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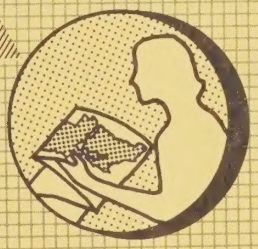

A GUIDE TO ABAG'S EARTHQUAKE HAZARD MAPPING CAPABILITY

ABAG ASSOCIATION OF BAY AREA GOVERNMENTS

ABAG
Association of Bay Area Governments
Hotel Claremont • Berkeley, California 94705 • (415) 841-9730

August 16, 1982

Dear Colleague:

We are pleased to forward the latest revision of our publication, A Guide to ABAG's Earthquake Hazard Mapping Capability. The guide is the result of a project funded by the U.S Geological Survey. The latest phase of that project also resulted in three new working papers which have been forwarded to you. Additional copies of the working papers and guide can be obtained from the ABAG Publications Office for the following minimal charges:

Report	Cost (add $1 each for handling)
A Guide to ABAG's Earthquake Hazard Mapping Capability	$ 4.00
Working Paper #16 - Detailed Map Information for Selected Existing Urbanized Areas and Landslide Susceptibility Hazard Map Refinement	1.50
Working Paper #17 - Using Earthquake Intensity and Related Damage to Estimate Risk of Ground Shaking Damage (including 5 map plates)	12.00
Working Paper #18 - Using Earthquake Hazard Maps to Analyze the Vulnerability of Lifeline System Locations	3.50

You may be interested to know that we expect to start on a project--to investigate the liability of the private sector for earthquake hazards and losses--within a month. As with an earlier project focusing on earthquakes and local government liability, this work will be funded by the National Science Foundation.

Sincerely,

Jeanne B. Perkins

Jeanne B. Perkins
Earthquake Preparedness Program Manager

Enclosure

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A GUIDE TO

ABAG'S

EARTHQUAKE HAZARD MAPPING

CAPABILITY

REVISED JUNE 1982

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ACKNOWLEDGEMENTS:

We would like to thank those many people at USGS and working for cities and counties in the Bay Area who took the time to review the many papers that form the basis for this guide.

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INTRODUCTION

PURPOSES

Since February 1979, ABAG has been developing a series of computer-based map files showing various basic data maps related to earthquakes and several maps derived from those illustrating various earthquake hazards. The project was started for two reasons:

- o to provide information that could be used by local governments in their seismic safety and safety programs.
- o to provide an input to various other planning programs at ABAG.

FORMAT

This project, unlike many that result in the publication of a final report, will be continuing and various map files will be expanded or upgraded. Therefore, this guide has been designed as a loose-leaf folder so that pages or sections can be replaced or added as ABAG's earthquake hazard mapping capability changes and expands.

The guide contains this introduction and three main sections:

- o a set of sheets describing each of the basic data map files and a cover sheet for that section
- o a set of sheets describing each of the hazard map files and a cover sheet for them.
- o a set of sheets describing several applications for the map files (also with a cover sheet).

The guide has also been designed to include a set of the working papers that have been developed to further describe the assumptions that were made and the data used to develop the hazard maps. A sheet summarizing the Working Papers is at the end of the report.

PROJECT PHASES

The first phase of the project focused on developing an operational earthquake hazard mapping capability and demonstrating some sample uses for researchers and local government technical staff. Files of basic data maps on generalized geology (four bedrock categories), faults, and dam failure and tsunami inundation areas were compiled for the entire nine-county Bay Area. Detailed information on hillside geology, as well as data on landslide deposits and topography, were compiled only for San Mateo County due to the expense of entering these data into the computer system. These basic data map files were manipulated to produce a series

of hazard map files for the region or San Mateo County; including:

- o maximum ground shaking intensity
- o cumulative risk of damage from ground shaking;
- o liquefaction susceptibility, both earthquake-induced and railfall-induced;
- o dam failure and tsunami inundation; and
- o composite maps combining all these hazard maps.

The detailed ground shaking maps, landslide susceptibility maps and composite maps were produced only for San Mateo County.

The second phase of the project expanded the area for which detailed hillside geology, landslide deposits and topographic information is in ABAG's computer data base by fifteen 71/2 minute quadrangles. These areas - Petaluma and its vicinity, and parts of the east Bay ridgelands of Santa Clara, Alameda and Contra Costa counties - were chosen as areas subject to extensive development pressure. The detailed basic data maps were used to develop more refined maximum ground shaking and risk maps, landslide susceptibility maps, and composite maps. These maps, together with those developed in the first contract, then were used in sample applications in local general plans, to provide computer-derived background reports for Environmental Impact Reports (EIRs), to screen areas for possible sites for key facilities, and to assess the vulnerability of existing and projected land uses and population to damage from a major earthquake.

The third and most recent phase focused on lifeline networks in the Bay Area, including major highways and railroads, electrical and gas networks, water supply aqueducts, and solid waste systems. Since lifeline problems are located largely in areas of existing urban development, this work is a logical complement to the second phase work, which focused on areas subject to rapid new development. Detailed information on hillside geology, landslide deposits, and topography was added to ABAG's computer data base for fifteen additional quadrangles in the central Bay Area. Again, the detailed basic data maps were used to develop more refined maximum ground shaking and risk maps and landslide susceptibility maps. These maps then will be used to provide detailed information on physical hazards, not structural hazards, associated with the location of these lifeline systems. The audience for these products is being broadened to include people and agencies operating and regulating lifeline systems, as well as local government staff.

EARTHQUAKE MAPPING AND ABAG'S EARTHQUAKE PREPAREDNESS PROGRAM

ABAG'S concerns about earthquake safety grew out of three separate, but related, programs. ABAG served as a liaison with other regional planning agencies and with county and local governments in the San

Francisco Bay Region Environment and Resources Planning Study. The study, begun in January 1970, was jointly sponsored by the U.S. Geological Survey and the Department of Housing and Urban Development. ABAG completed a report for this study in February 1976, Quantitative Land Capability Analysis - A Method of Applying Earth Science Information to Planning and Decision Making. The report describes the use of benefit-cost analysis in weighing the relative importance of selected earth science hazards, constraints and resources. The report was published as U.S.G.S. Professional Paper 945 in 1979.

During the same period, ABAG prepared a booklet entitled Hazards Evaluation for Disaster Preparedness Planning summarizing the results of a study on evaluating hazards sponsored by the Defense Civil Preparedness Agency of the Department of Defense, completed in August 1975. The project focused on developing a standard method for evaluating earthquakes and several other natural and man-made sources of disasters.

The findings of these reports, as well as other related information, were given to ABAG's member governments in February, 1976 at a General Assembly entitled "On Shaky Ground". ABAG's General Assembly indicated that a program to help prepare the region for coping with major earthquakes is extremely important. Such a program also has been supported by ABAG's Executive Board, Work Program and Coordination Committee and various other committees.

These desires led to the revision of ABAG's General Plan to include several objectives dealing with improving seismic safety and a series of actions to accomplish these objectives focusing on:

- o incorporating seismic safety concerns into ABAG's plan and project review function
- o supporting or advocating legislation at the State and federal level
- o providing assistance to ABAG's member governments in improving their safety and seismic safety programs

The service activities have led to several recent projects, including:

- o a survey of local regulations related to geologic and hydrologic hazards, constraints and resources
- o a survey of geotechnical study costs
- o a review of earthquake insurance issues
- o an extensive review of earthquake hazards and local government liability

The study of liability also resulted in ABAG's advocacy of State legislation that was passed by the legislature and signed by the Governor in 1979.

This earthquake mapping project is providing strong technical support for the Earthquake Preparedness Program. It is enabling ABAG staff to conduct land capability type analyses not only for all nine Bay Area counties, but also at the fine resolution of one hectare (2-1/2 acres).

These overlaying and modeling capabilities are extremely important not only for creating the hazard maps in the first place, but also for combining earthquake hazard concerns with other physical and social constraints for site evaluation and impacts analyses.

EARTHQUAKE MAPPING AND THE BAY AREA SPATIAL INFORMATION SYSTEM (BASIS)

This project is closely tied to ABAG's BASIS program. A major objective of BASIS is to develop a regional geographic data base that can be directly used in local, as well as regional, planning applications. It was developed to tie together the data development and map analysis different computers and different resolutions. (The land capability study that used a system at the University of California at Davis was one such application.)

BASIS is structured around an array of grid cells, each representing a land area of one hectar (100 meters square) in the UTM coordinate system. It requires over two million of these cells to cover the nine-county Bay Region. Each cell on the ground corresponds to one unit of computer storage; the unit contains data codes representing the characteristics of that cell. Data can be acquired either by reading a tape or by digitizing a map. BASIS is capable of using data based on other coordinated systems (such as longitude/latitude or LANDSAT reference points) by mathematically transforming these reference systems to a common UTM base. This project greatly increases the data available for each cell. The basic data map files listed in the main body of this guide are a product of direct data acquisition.

Much of the power of BASIS lies in its ability to manipulate the basic data map files. A composite of many data sets can be produced through an overlay or modeling process, and can include distance searches or other calculations. Most of the hazard map files are the product of these proceses.

BASIS currently runs on Geogroup Corporation's computer system, which can handle data transfer to or from most other computer systems. The computer configuration includes a digitizer for encoding mapped data, an electrostatic plotter for producing computer maps, and a high resolution dot matrix printer. The V76 computer contains 128K words of fast semiconductor memory and special operations for handling mathematical operations of high speeds. Six terminals on-line to the computer are used fo data entry and user interaction. Data storage is on one 88M byte disk drive and one nine-track tape drive. The present computer system (developed by Convergent Technologies) is a cluster of two work stations, each of which contains a processor and 256K bytes of memory. Data storage is presently on one 20M byte disk. A nine-track tape drive and standard floppy disks are used for file back-up and data transfer. Geogroup staff are responsible for all programming work.

BASIS DATA MAP FILES

As of June 1982, the earthquake hazard maps are based on six basic data map files described on the following pages:

- o geology
- o faults
- o topography
- o landslides
- o tsunami inundation areas
- o dam failure inundation areas

In addition, a land use file, and files of selected lifeline systems, have been created to illustrate some applications.

Each of the following sheets consists of five major sections describing various aspects of the map file on the front. The five sections include:

- o Coverage - the area of the region covered (including a map) and the resolution of the data
- o Source - the scale and name of the source used (if many sources are used a working paper containing the complete list may be referenced)
- o Major categories on map - the categories in the file are listed to the extent practicable
- o Used with other files to produce hazard files on - a cross-reference to the hazard map files using this basic data file
- o Limitations and future plans - limitations in coverage or accuracy are described, together with future plans to upgrade each file

A 1:1 million scale reproduction of the file appears on the back for illustration only. At this scale, a complete map explanation would be meaningless. Potential users should contact ABAG staff to obtain maps of their area of interest and an explanation for those maps.

There are other basic files in BASIS that have not been improved in conjunction with this earthquake mapping project. These files can be divided into two categories, files depicting the physical environment and those depicting the social environment:

PHYSICAL ENVIRONMENT

- o average annual precipitation - region-wide
- o vegetation - region-wide
- o National Flood Insurance Program maps - unincorporated areas and some cities
- o flood-prone areas defined by U.S.G.S. in 1972 - region-wide
- o coastline features from U.S.G.S. 7-1/2 minute quadrangles - region-wide
- o soil associations (generalized from soils types) - region-wide
- o average yield from wells - region-wide
- o digital terrain tape elevations - region-wide.
- o slope stability (generalized to 25 hectare resolution) - region-wide
- o air quality problem areas - region-wide

SOCIAL ENVIRONMENT

- o 1970 census tracts - region-wide (1980 census tracts are available for selected applications)
- o county boundaries - region-wide
- o city sphere-of-influence boundaries - region-wide
- o airports, seaports, vacant industrial lands - region-wide
- o landfill sites and service areas

GEOLOGY

BASIC DATA MAP FILE

COVERAGE: All Bay Area counties with the central Bay Area in more detail

SOURCE:
SCALE: 1:62,500 and 1:24,000 (for geology) and 1:125,000 (for flatlands deposits)
NAME: U.S.G.S. Professional Paper 944--Flatlands deposits of the S.F. Bay Area; Geology Maps by various U.S.G.S. and C.D.M.G. authors (see Working Paper #17 for more information).

June 1982
Hectare resolution

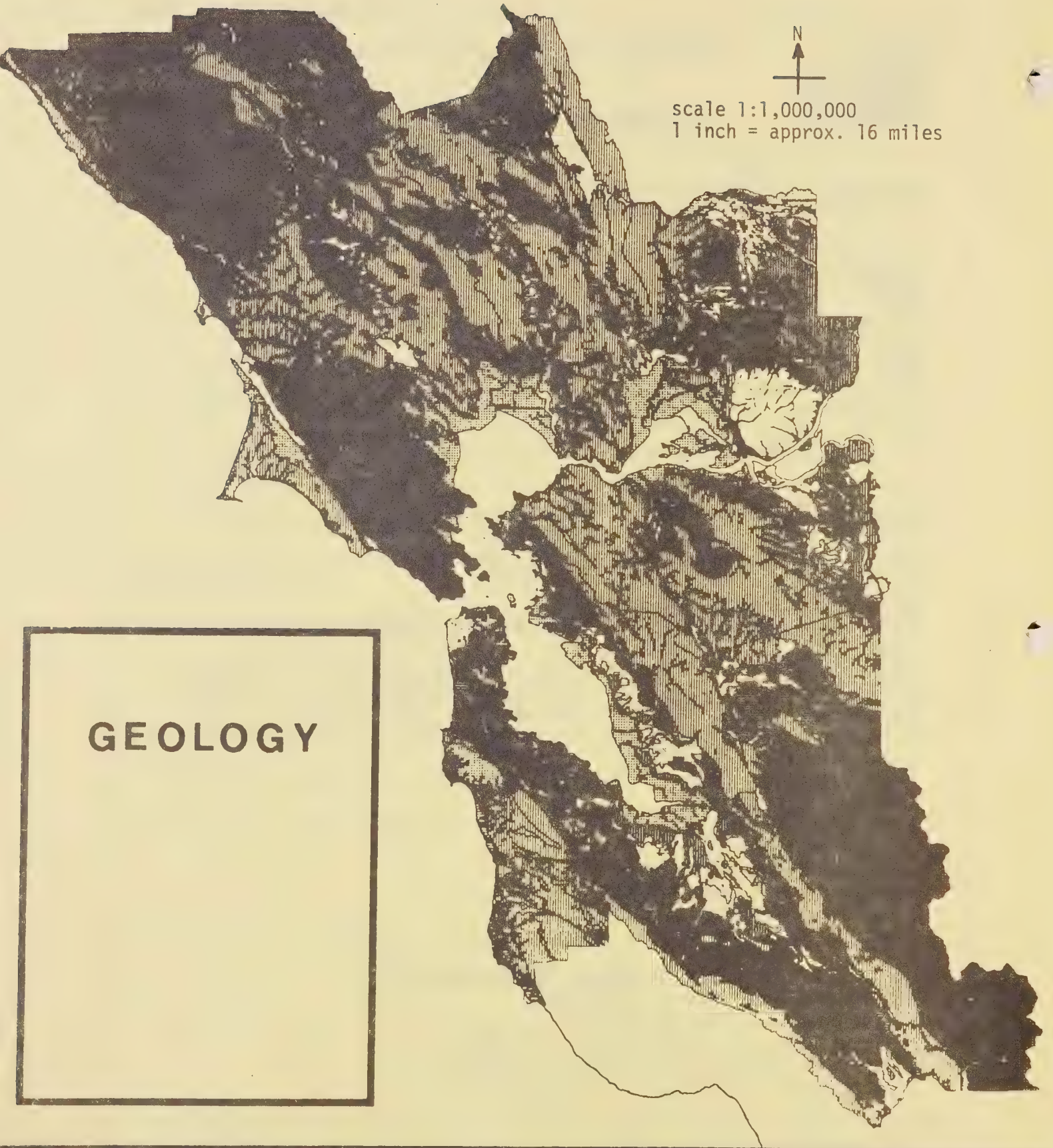
MAJOR CATEGORIES ON MAP:
Holocene stream channels
Holo. alluvium - coarse
Holo. alluvium - fine
Holo. basin deposits
Quaternary colluvium
Holo. beach and sand deps.
Holo. Bay mud
Artificial fill
Pleistocene sand
Pleis. marine terrace
Pleis. alluvium - coarse
Pleis. alluvium - fine
Late Pleis. alluvium
Early Pleis. alluvium
Colma Formation
Montezuma Hills Formation
Quaternary undivided (urban)
Franciscan Assemblage (General)
Granitic rocks (General)
Materials of Quat./Tertiary age (General)
Other Tertiary or older materials (General)

ADDED FOR THE CENTRAL BAY AREA:

The last four categories are broken into 104 geologic formations and members. For example, the Franciscan is subdivided into many rock types.

USED WITH OTHER FILES TO PRODUCE HAZARD FILES ON:
- o maximum ground shaking intensity
- o risk of ground shaking damage
- o liquefaction susceptibility and potential
- o rainfall-induced landslide susceptibility
- o earthquake-induced landslide susceptibility

LIMITATIONS AND FUTURE PLANS:
The geology file currently is available only in detail for 46 quadrangles. The level of detail will be increased for other areas as time and money become available.



GEOLOGY

BASIS

BAY AREA SPATIAL
INFORMATION SYSTEM

FAULTS

BASIC DATA MAP FILE

COVERAGE: All Bay Area counties and parts of adjacent counties

June 1982
Hectare resolution

SOURCE:
SCALE: Largely 1:24,000 with some at 1:60,000, 1:125,000, and 1:250,000
NAME: Special Studies Zones Maps prepared by the State Geologist and additional mapping of fault traces by U.S.G.S. personnel of faults they consider active or probably active. (See Working Paper #17 for a list of sources for the mapping used.)

MAJOR CATEGORIES ON MAP AS STUDY ZONES:

San Andreas*
Hayward*
Crosley*
Calaveras*
San Gregorio*
Maacama
Healdsburg*
Rodgers Creek*
Tolay*
Concord*
Green Valley*
Antioch*
Evergreen*
Pleasanton*
Serra
Silver Creek*
Piercy
Coyote Creek
Sargent*
Butano
Monte Vista*
Shannon
Greenville
Las Positas
Verona

AS FAULT TRACES

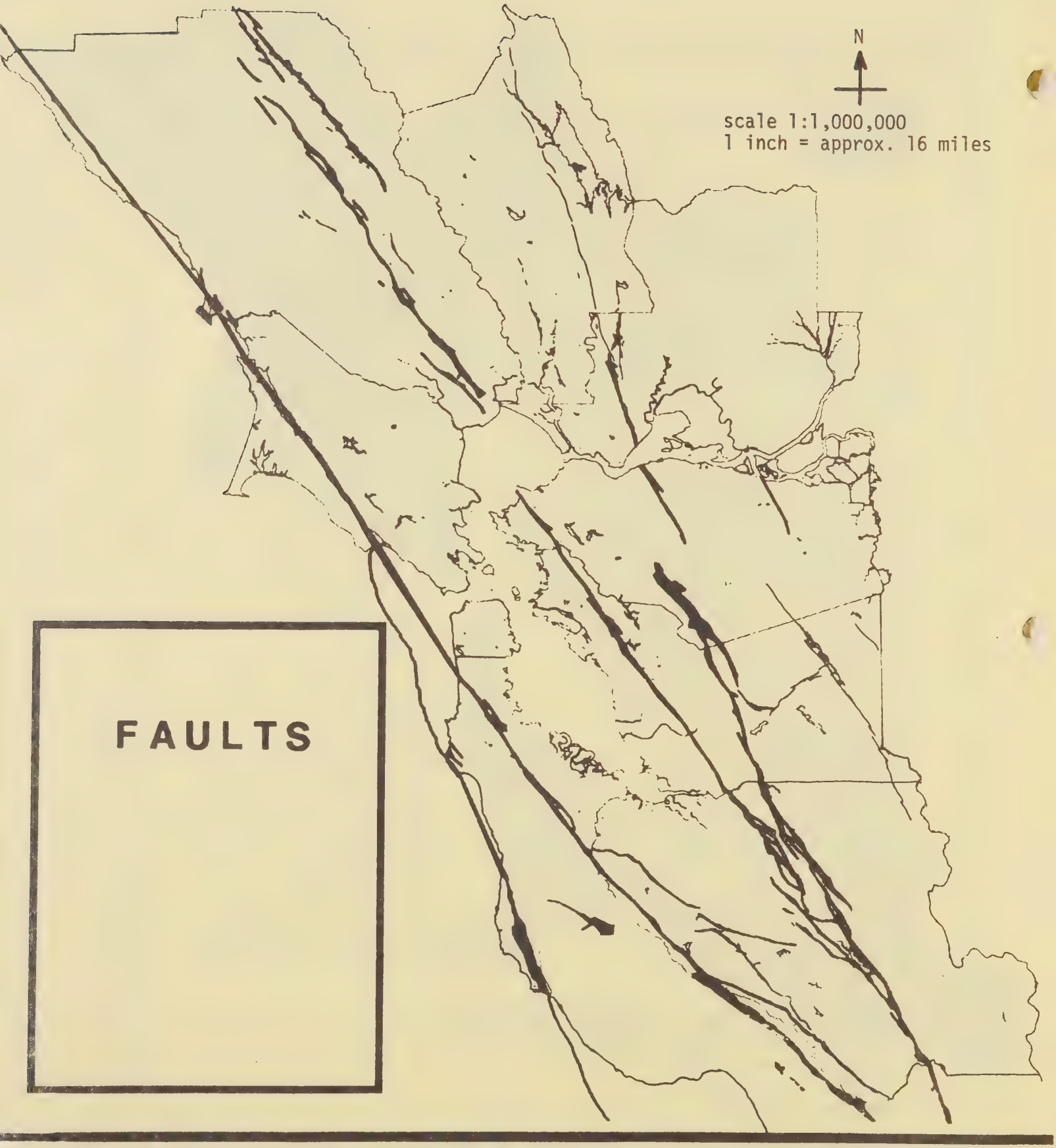
Greenville*
Las Positas*
Verona*
Berrocal*
San Joaquin*
Midway*
West Napa*
Cordelia*
Dunnigan Hills*
Faults near Trenton*
Maacama*
East of Santa Rosa*
East of Bennett Valley*
Zayante*
Green Valley*

*included in intensity mapping (main faults only; no branches)

USED WITH OTHER FILES TO PRODUCE HAZARD FILES ON:

- o maximum ground shaking intensity
- o risk of ground shaking damage
- o liquefaction potential
- o surface rupture

LIMITATIONS AND FUTURE PLANS:
Changes in Special Studies Zones and in fault traces will be made as new information becomes available. Traces of faults mapped as Study Zones generally are not included. These traces could be added at a future time if money becomes available.



BASIS

BAY AREA SPATIAL INFORMATION SYSTEM

TOPOGRAPHY

BASIC DATA MAP FILE

COVERAGE: The central Bay Area only
(Map on back covers San Mateo County)

SOURCE:
SCALE: Hectare resolution tapes

NAME: Digital terrain model tapes from U.S.G.S. with elevation accuracy of + or - 7 meters

June 1982
Hectare resolution

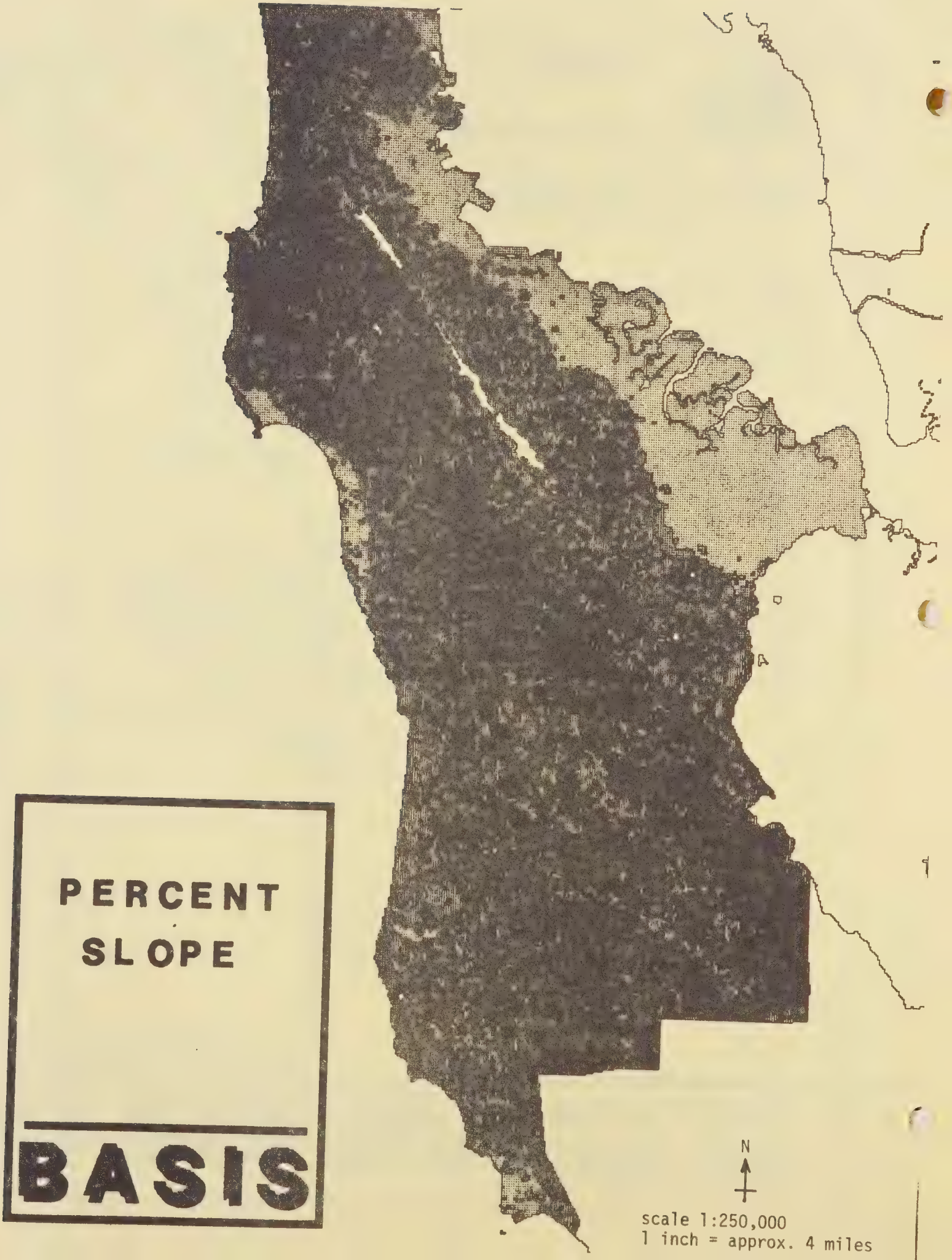
MAJOR CATEGORIES ON MAP:
Average elevation, in meters, for each hectare

In addition, where the digital elevation model data is available, a program has been run to produce the maximum slope by using the maximum change in elevation between any given cell and the eight surrounding cells (allowing for the longer distance between the cell and those at the four diagonal corners). Other ways of producing slope files could be produced at the request of potential users. The slope file is currently stored as six categories:

0 - 5% slope	30 - 50% slope
5 - 15% slope	50 - 70% slope
15 - 30% slope	100+% slope

USED WITH OTHER FILES TO PRODUCE HAZARD FILES ON:
- o rainfall-induced landslide susceptibility
- o earthquake-induced landslide susceptibility

LIMITATIONS AND FUTURE PLANS:
The topography file is available only for the central Bay Area. The file will be expanded further as money becomes available. When using this file, one should remain aware of the limitations in elevation accuracy (within 7 meters) and spatial accuracy (one hectare for most applications).


PERCENT
SLOPE
BASIS
N
scale 1:250,000
1 inch = approx. 4 miles

LANDSLIDES

BASIC DATA MAP FILE

COVERAGE: The central Bay Area only
(Map on back covers San Mateo County)

June 1982
Hectare resolution

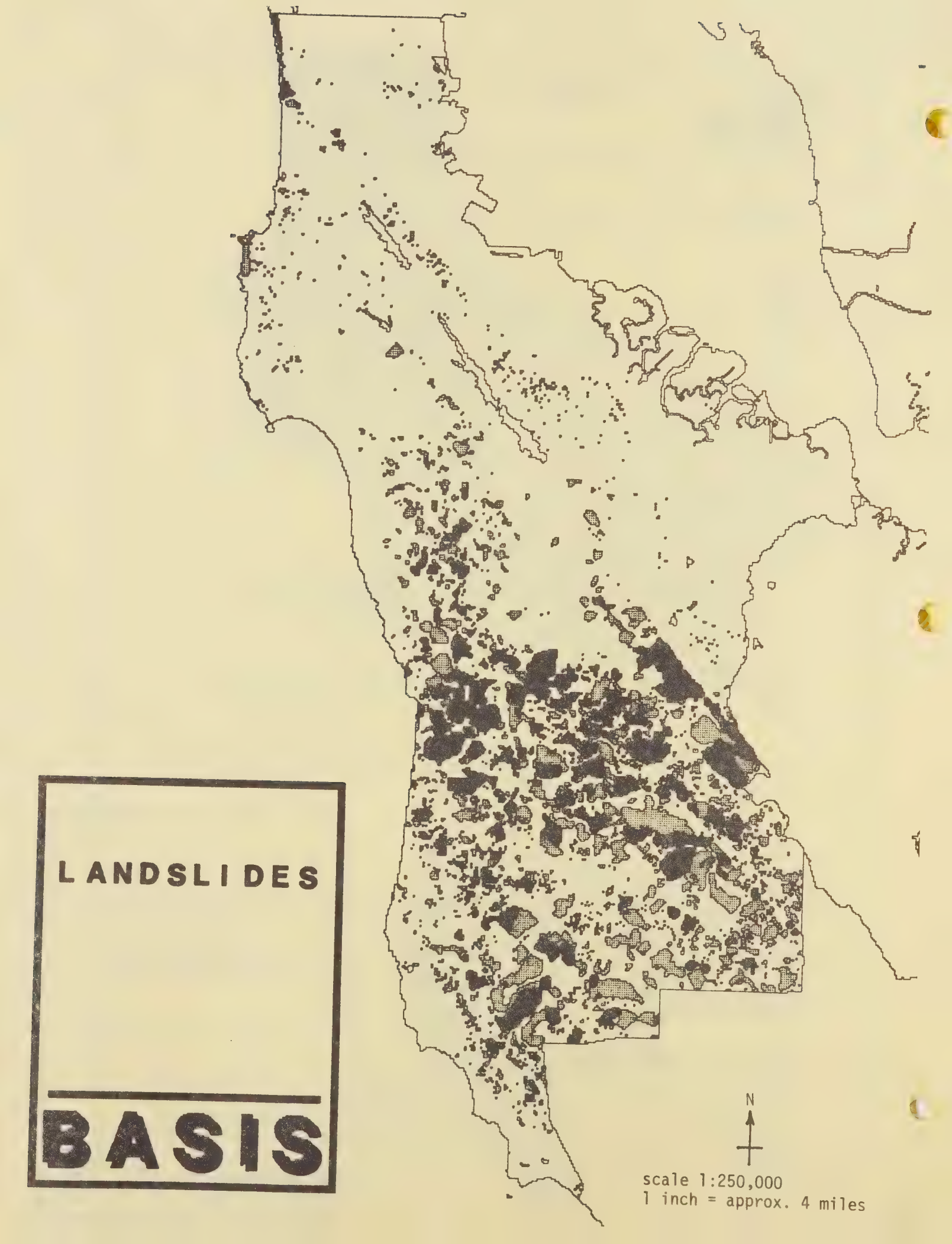
SOURCE:
SCALE: 1:62,500
NAME: Preliminary Map of Landslide Deposits in San Mateo County, CA (1972) by Earl Brabb and Earl Pampeyan of U.S.G.S. (Misc. Field Studies Map MF-344) based on aerial photos with some field checking and some use of local government records and consultants reports.

MAJOR CATEGORIES ON MAP:
Large landslide - definitely present
Large landslide - probably present
Large landslide - of questionable presence
Large landslide - definitely present, of questionable activity
Large landslide - probably present, of questionable activity
Large landslide - field checked and definitely active
Small landslide - mapped from aerial photographs
Small landslide - mapped in the field
Small landslide - subsidence of road or ground from public sources
Small landslide - active landslide mapped from public sources
Small landslide - active landslide mapped by private firm

In addition, an area of historic liquefaction (from the 1906 earthquake) in San Mateo County is included on this file based on data supplied by Les Youd of U.S.G.S.

USED WITH OTHER FILES TO PRODUCE HAZARD FILES ON:
- o rainfall-induced landslide susceptibility
- o earthquake-induced landslide susceptibility
- o liquefaction susceptibility and potential (the area of historic liquefaction)

LIMITATIONS AND FUTURE PLANS:
The file is available only for the central Bay Area. The file will be expanded further as time and money become available. The file has been set up to allow for the inclusion of data from local government files and consultants reports. This data, even for San Mateo Co., is out of date.


LANDSLIDES
BASIS
N
scale 1:250,000
1 inch = approx. 4 miles

TSUNAMI INUNDATION AREAS

BASIC DATA MAP FILE

COVERAGE: All nine Bay Area counties

SOURCE:
SCALE: 1:125,500

NAME: Map Showing Areas of Potential Inundation by Tsunamis in the San Francisco Bay Region, CA (1972) by J.R. Ritter and W.R. Dupre of U.S.G.S. (Misc. Field Studies Map MF-480) based on a 500-year event. See Working Paper #6.

March 1980
Hectare resolution

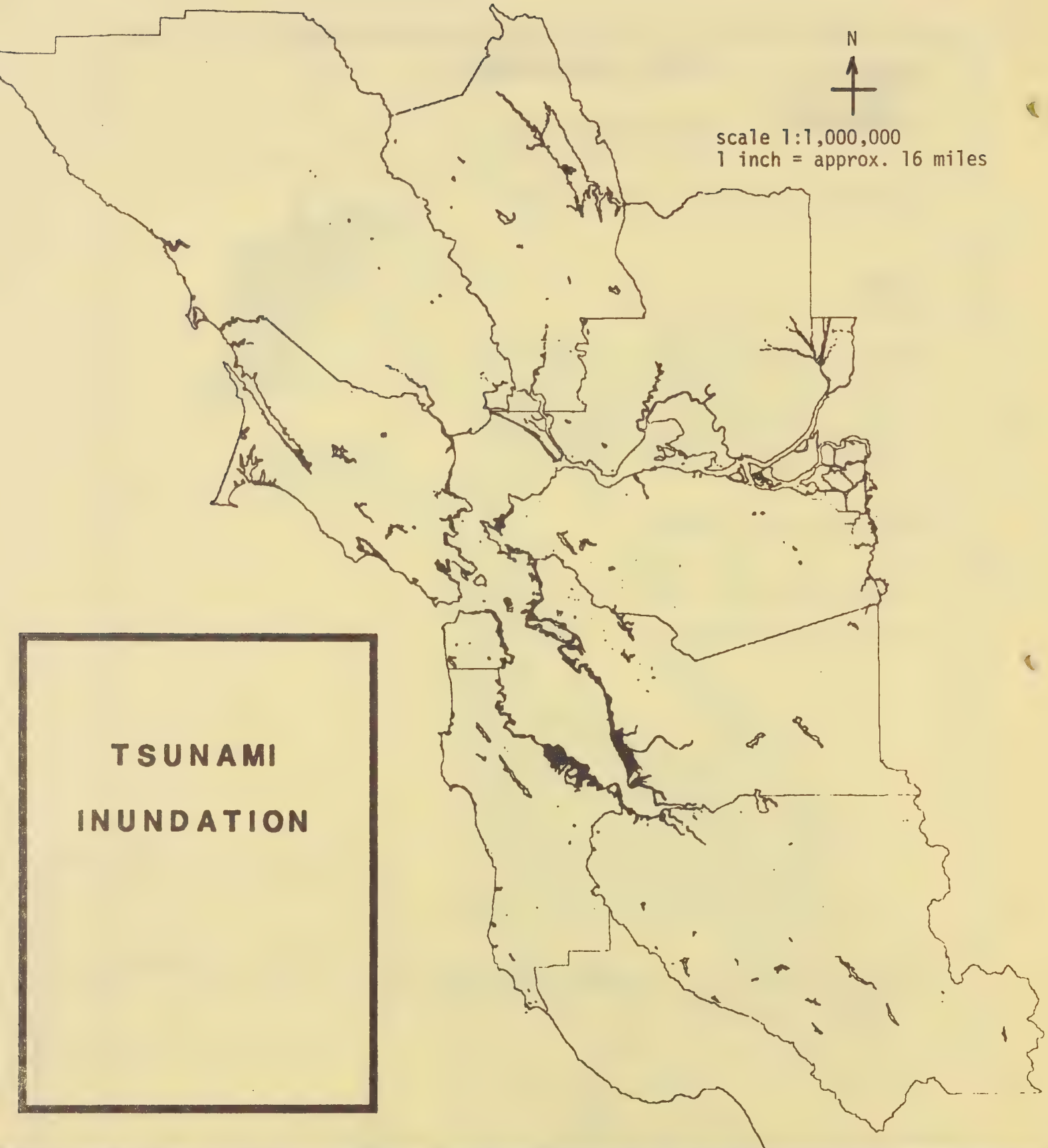
MAJOR CATEGORIES ON MAP:

Within areas to be inundated
Outside areas to be inundated

(no depth information is provided)

USED WITH OTHER FILES TO PRODUCE HAZARD FILES ON:
o tsunami inundation areas

LIMITATIONS AND FUTURE PLANS:
More detailed mapping showing depth of inundation currently is not available in usable form. However, special studies being done in conjunction with the Federal Flood Insurance Program should be available by early 1981. The possibility of replacing this file with more detailed information will be examined at that time.



TSUNAMI INUNDATION

BASIS BAY AREA SPATIAL INFORMATION SYSTEM

DAM FAILURE INUNDATION AREAS

BASIC DATA MAP FILE

COVERAGE: All nine Bay Area counties

March 1980
Hectare resolution

SOURCE:
SCALE: Originals from 1:2,400 to 1:24,000 all redrafted at 1:24,000
NAME: Maps submitted by dam owners to the California Office of Emergency Services to comply with the California Dam Safety Act (Section 8589.5 of the Government Code) for those dams or reservoirs whose total failure would cause injury or loss of life.

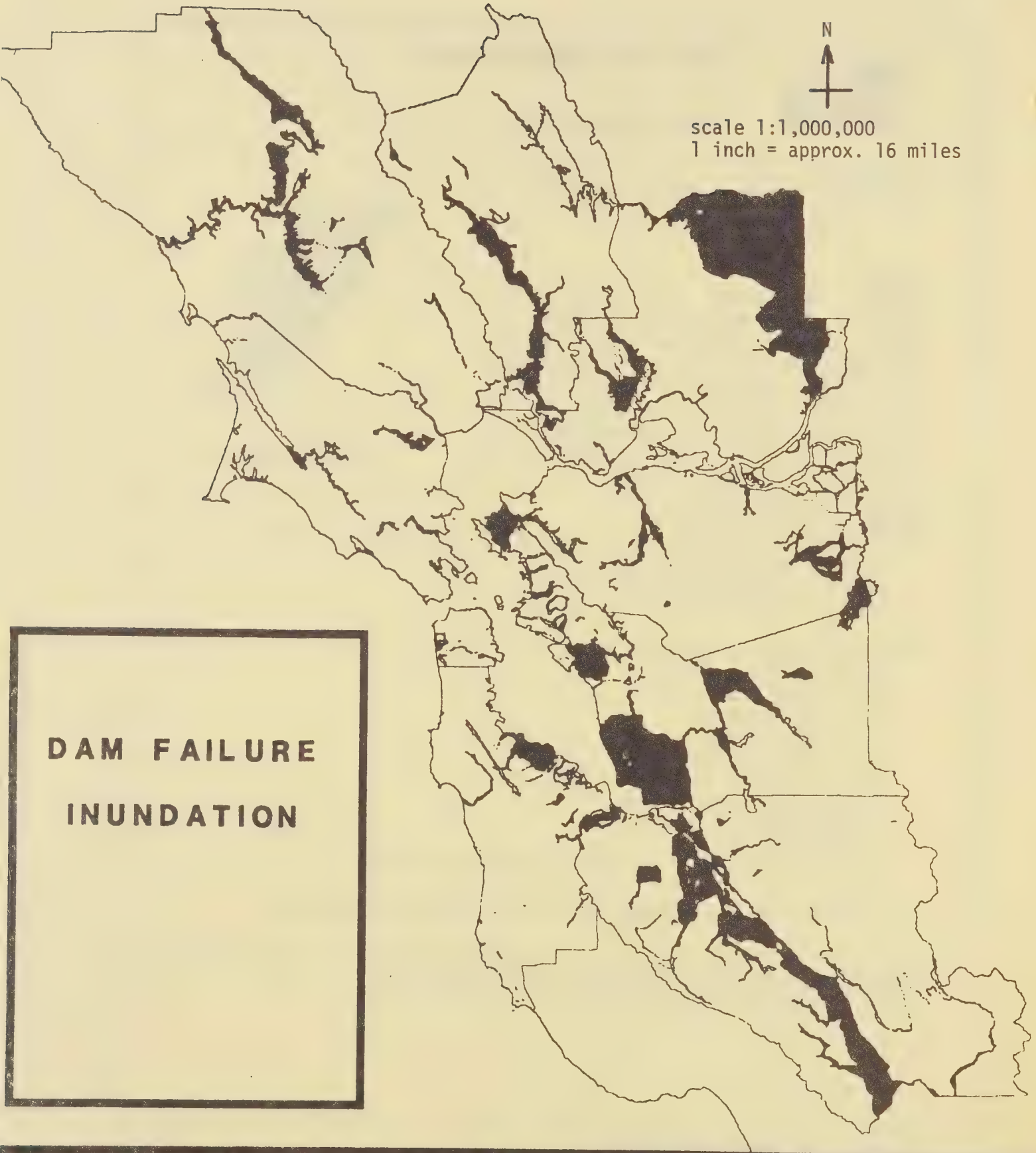
MAJOR CATEGORIES ON MAP:
For each of the 134 dams where inundation maps were required:
- within the inundation area
- outside of the inundation area
- (no depth information is provided)

The dams for which maps are provided include:
- 28 in Alameda County
- 24 in Contra Costa County
- 4 in Marin County
- 16 in Napa County
- 6 in San Francisco
- 11 in San Mateo County
- 28 in Santa Clara County
- 9 in Solano County
- 7 in Sonoma County
- 1 from Mendocino County affecting Sonoma County

A complete list of the dams is included in Working Paper #7.

USED WITH OTHER FILES TO PRODUCE HAZARD FILES ON:
o dam failure inundation areas

LIMITATIONS AND FUTURE PLANS:
The State Department of Water Resources established the criteria to be used by the dam owners to produce the maps and reviewed the completed maps for compliance with the criteria. The file does not contain information on depth of inundation although this information is available from some of the dam owners.



DAM FAILURE INUNDATION

BASIS BAY AREA SPATIAL INFORMATION SYSTEM

LAND USE--1975-1976

BASIC DATA MAP FILE

COVERAGE: San Mateo County only

SOURCE:
SCALE: 1:24,000

NAME: Land Use and Land Cover Maps prepared by U.S.G.S. showing four levels of land use categories; the maps are published as U.S.G.S. Open File Maps 78-738 to 78-755 and use the classification of Anderson and others of U.S.G.S. described in Prof. Paper 964.

March 1980
Hectare resolution

MAJOR CATEGORIES ON MAP:

Urban or Built-up Land
Residential
  3 sub-categories
Commercial and services
  7 sub-categories with
  1 further subdivided
Industrial
  2 sub-categories
Transportation, communication and utilities
  6 sub-categories
Commercial and industrial complexes
Mixed urban or built-up land
Other urban or built-up land
  4 sub-categories with
  1 further subdivided

Agricultural Land
Cropland and pasture
  2 subcategories with
  1 further subdivided
Orchards, groves, vineyards, nurseries and ornamental horticulture
  3 sub-categories
Confined feeding operations
Other agricultural land

Rangeland
Herbaceous rangeland
Shrub and brush rangeland
  2 sub-categories
Mixed rangeland

Forest Land
Deciduous forest land
Evergreen forest land
  3 sub-categories
Mixed forest land

Water
Streams and canals
Lakes
Reservoirs
Bays and estuaries

Wetland
Forested wetland
Non-forested wetland

Barren Land
Dry salt falts
Beaches
Sandy areas other than beaches
Bare exposed rock
Strip mines, quarries and gravel pits
Transitional areas
  2 sub-categories
Mixed barren land

USED WITH OTHER FILES TO PRODUCE HAZARD FILES ON:
o used only on applications

LIMITATIONS AND FUTURE PLANS:
This file is only available for San Mateo County. A file for the entire region of only the first two levels of categories (no sub-categories or further divisions) for the other eight counties in the region could be obtained if time and money become available.

LAND USE
1975 1976
BASIS
N
scale 1:250,000
1 inch = approx. 4 miles

LIFELINES

BASIC DATA MAP FILE

COVERAGE: All nine Bay Area counties

June 1982
Hectare resolution

SOURCE:
SCALE: from 1:24,000 to 1:250,000
NAME: Wastewater discharge mains, treatment facilities and treatment plant service areas; water supply and distribution mains and water service areas; major highways and associated structures; BART stations and lines; railroads; powerlines and fuel pipelines.

MAJOR CATEGORIES ON MAP:

- o 74 waste water treatment plants with their associated discharge lines and service areas
- o 236 water supply and distribution main segments and 84 water supply agency service areas
- o 1959 highway structures and 211 highway segments
- o 36 BART stations and buildings and 68 line segments with data on line elevation
- o 57 railroad segments with data on owner and whether it is used as a passenger line
- o 13 categories of oil and energy company pipelines
- o 4 categories of powerlines based on voltage or whether they are underground.

USED WITH OTHER FILES TO PRODUCE HAZARD FILES ON:

- o used only on applications

LIMITATIONS AND FUTURE PLANS:
The data is only as accurate as the base maps from which it was taken. Treatment plant service areas and water supply agency service areas are from relatively old maps (1970) with only minor changes.

BASIS

BAY AREA SPATIAL INFORMATION SYSTEM

HAZARD MAP FILES

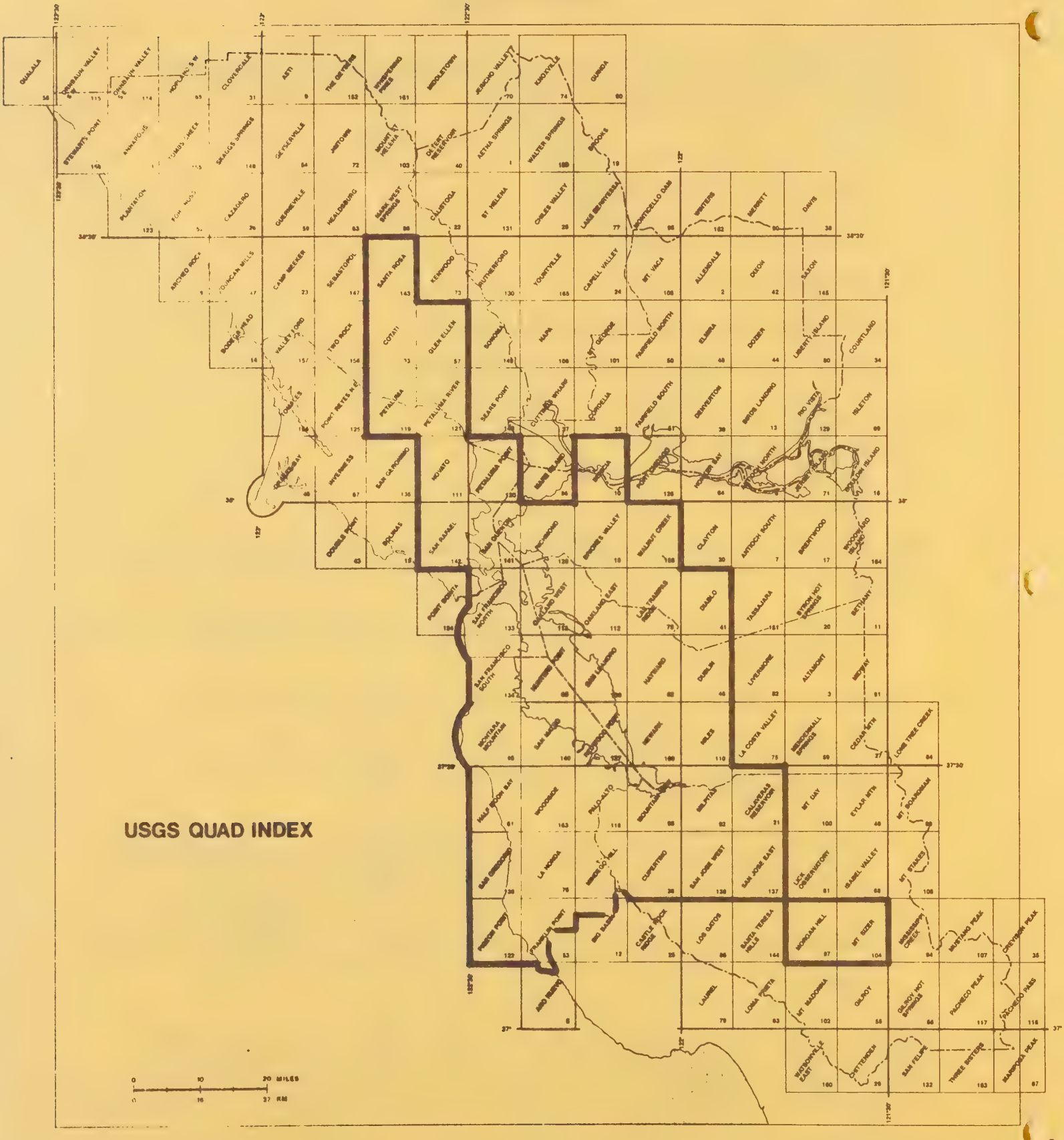
As of June 1982, the first six basic data maps have been combined to create six hazard map files and three of the basic maps have been converted to three additional hazard files:

- o maximum ground shaking intensity
- o risk of ground shaking damage
- o liquefaction susceptibility
- o liquefaction potential
- o rainfall-induced landslide susceptibility
- o earthquake-induced landslide susceptibility
- o fault surface rupture
- o tsunami hazard areas
- o dam failure hazard areas

Each of the following sheets consists of five major sections describing various aspects of the map files on the front. The five sections include:

- o Coverage - the area of the region covered (including a map) and the resolution of the data
- o Source - the basic data map files and the key assumptions used
- o Diagram of components - a figure depicting the interrelationship of the basic data map files used to create the hazard map files
- o Further information on this file is contained in - a list of the working papers further describing the map development and, if applicable, other relevant documents (complete citations are not provided but can be obtained from the working papers)
- o Limitations and future plans - limitations in coverage or accuracy are described, together with future plans to upgrade each file

A 1:1 million scale reproduction of the file appears on the back of each sheet. At this scale, an explanation of individual map categories is meaningless. Potential users should contact ABAG staff to obtain maps of their area of interest and an explanation for those maps.



THE CENTRAL BAY AREA -- THAT PORTION OF THE BAY AREA FOR WHICH ADDITIONAL BASIC DATA MAPS AND HAZARD MAPS ARE AVAILABLE

MAXIMUM GROUND SHAKING INTENSITY

HAZARD MAP FILE

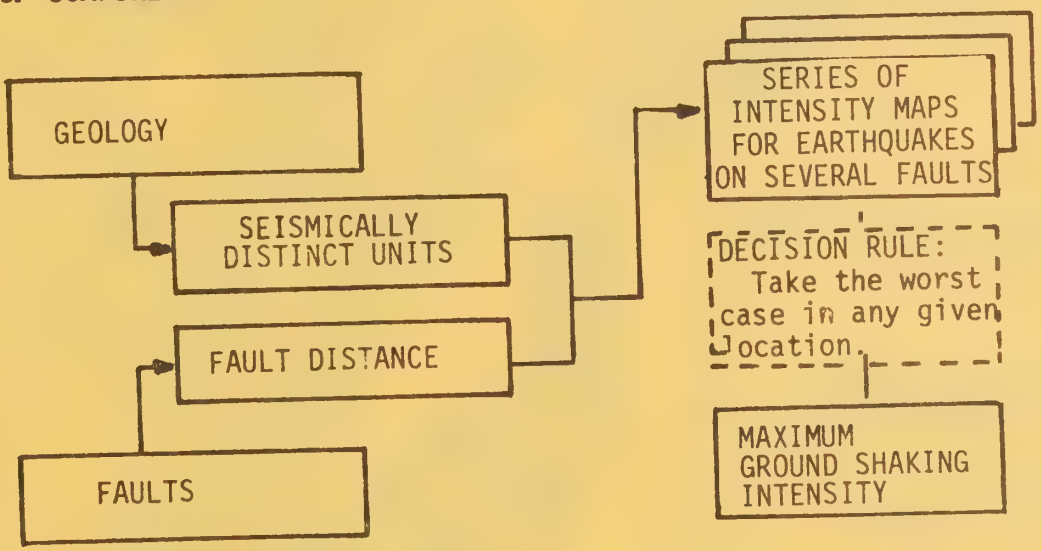
COVERAGE: All Bay Area counties with the central Bay Area in more detail

SOURCE: The basic data map files on faults and geology are combined to produce this map using data on:

- o maximum magnitude for each fault
- o maximum intensity associated with each maximum magnitude
- o the attenuation of intensity with distance from the fault rupture
- o the effect of local geology on intensity

June 1982
Hectare resolution

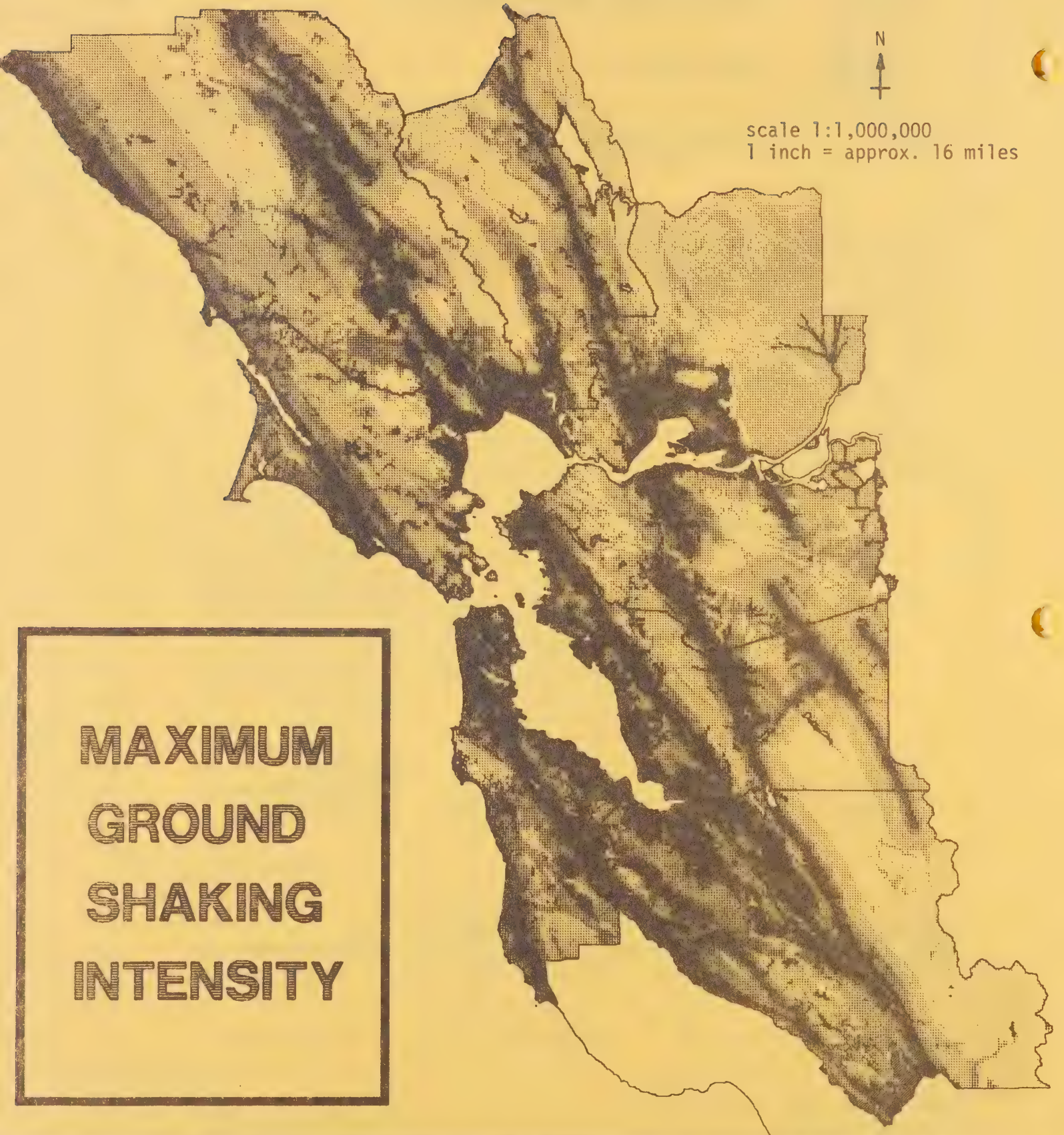
DIAGRAM OF COMPONENTS:


GEOLOGY
SEISMICALLY DISTINCT UNITS
FAULT DISTANCE
FAULTS
SERIES OF INTENSITY MAPS FOR EARTHQUAKES ON SEVERAL FAULTS
DECISION RULE: Take the worst case in any given location.
MAXIMUM GROUND SHAKING INTENSITY

FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:
Working Paper #17: Using Earthquake Intensity and Related Damage to Estimate Maximum Earthquake Intensity and Risk of Ground Shaking Damage

The method is from U.S.G.S. Professional Paper 941-A (Borcherdt & others)

LIMITATIONS AND FUTURE PLANS:
The difference in the detail of geology information between the central Bay Area and the rest of the region can be significant. This file will be recreated as new geology data is entered in the geology file, however. The intensity data is included as San Francisco intensities rather than as modified Mercali intensities. Data on attenuation for modified Mercali intensities would change the appearance of this file.



MAXIMUM GROUND SHAKING INTENSITY

BASIS

BAY AREA SPATIAL INFORMATION SYSTEM

RISK OF GROUND SHAKING DAMAGE

HAZARD MAP FILE

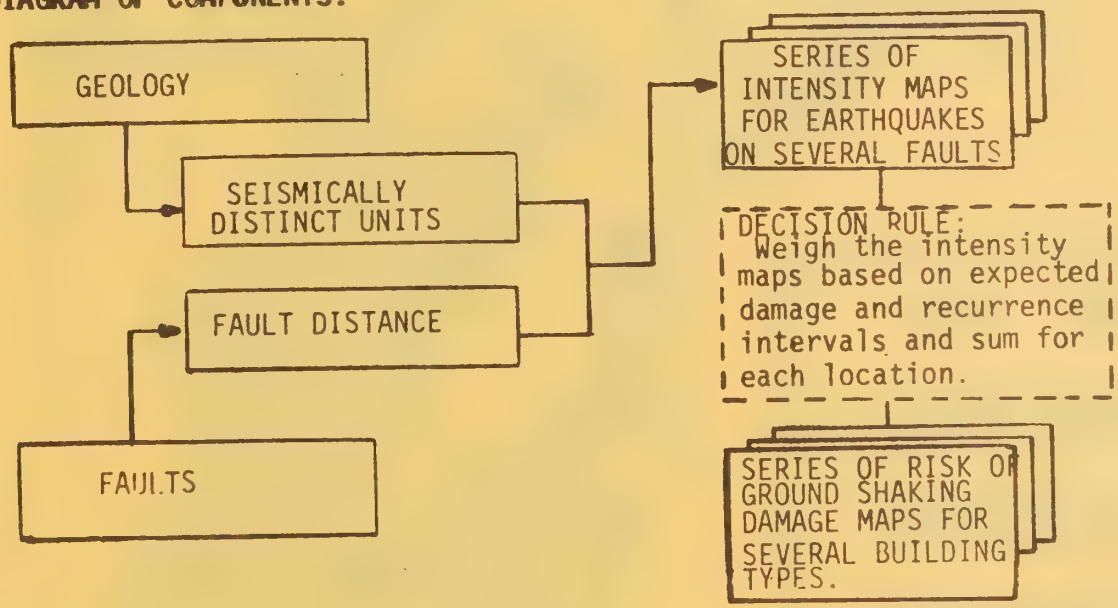
COVERAGE: All Bay Area counties with the central Bay Area in more detail

SOURCE: The basic data map files on faults and geology are combined to produce these maps using data on:

- o frequency of different magnitudes of earthquakes on each fault
- o damage associated with intensity
- o the source data used in the maximum ground shaking intensity file

June 1982
Hectare resolution

DIAGRAM OF COMPONENTS:


GEOLOGY
SEISMICALLY DISTINCT UNITS
FAULT DISTANCE
FAULTS
SERIES OF INTENSITY MAPS FOR EARTHQUAKES ON SEVERAL FAULTS
DECISION RULE: Weigh the intensity maps based on expected damage and recurrence intervals and sum for each location.
SERIES OF RISK OF GROUND SHAKING DAMAGE MAPS FOR SEVERAL BUILDING TYPES.

FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

- o Working Paper #17: Using Earthquake Intensity and Related Damage to Estimate Maximum Earthquake Intensity and Risk of Ground Shaking Damage

The method is a refinement of a technique described in an earlier ABAG publication, Earthquake Intensity and Expected Cost (1978).

LIMITATIONS AND FUTURE PLANS:

The difference in the detail of geology information between the central Bay Area and the rest of the region is fairly insignificant. This file will be recreated as more geology data becomes available. Better data on recurrence intervals of various magnitudes of earthquakes and on the long term slip rate of faults would greatly improve the reliability of the file. The damage data and resulting risk data are statistical and can be applied to building for comparison only.

RISK OF GROUND SHAKING DAMAGE

TILT UP CONCRETE BUILDINGS

BASIS BAY AREA SPATIAL INFORMATION SYSTEM

LIQUEFACTION SUSCEPTIBILITY

HAZARD MAP FILE

COVERAGE: All nine Bay Area counties

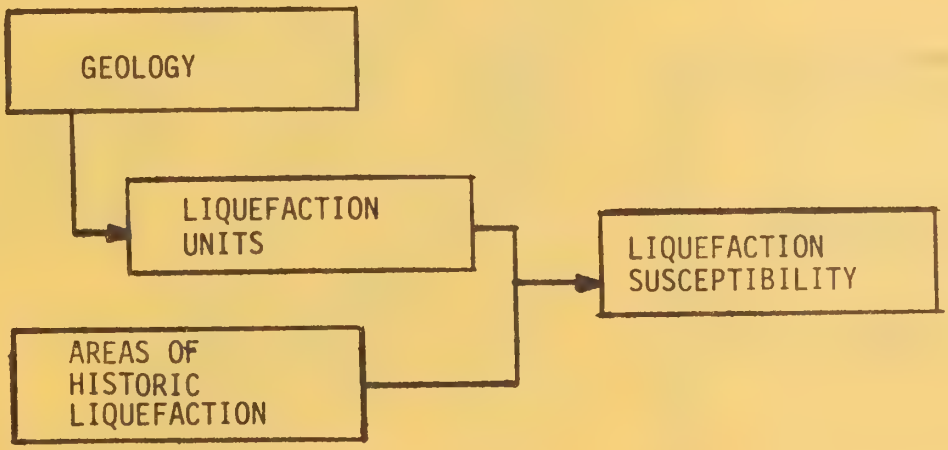
SOURCE: The basic data map file on geology was converted to a hazard file based on:

- o type and age of deposit
- o extent of cohesionless materials
- o possibility of cohesionless materials liquefying
- o likelihood of saturation

(historic liquefaction areas also included)

March 1980
Hectare reslution

DIAGRAM OF COMPONENTS:



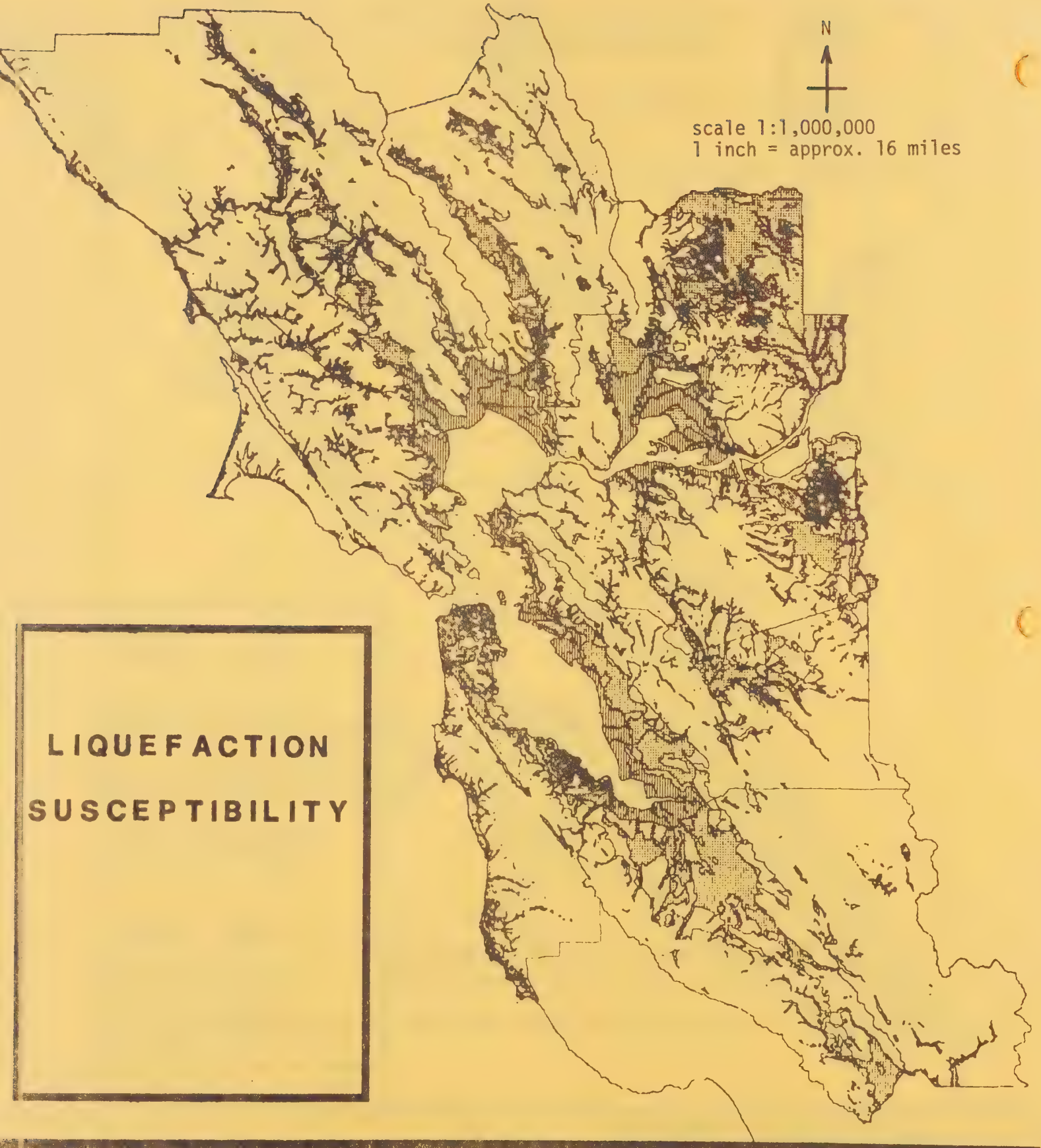
FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

o Working Paper #4: Liquefaction Potential Mapping

The method is based on several publications of Les Youd and others of U.S.G.S.

LIMITATIONS AND FUTURE PLANS:

The difference in the detail of geology information between the central Bay Area and the rest of the region does not affect this file. If a map of ground water table were available for the region, the data on saturation could be improved significantly.



LIQUEFACTION SUSCEPTIBILITY

BASIS BAY AREA SPATIAL INFORMATION SYSTEM

LIQUEFACTION POTENTIAL

HAZARD MAP FILE

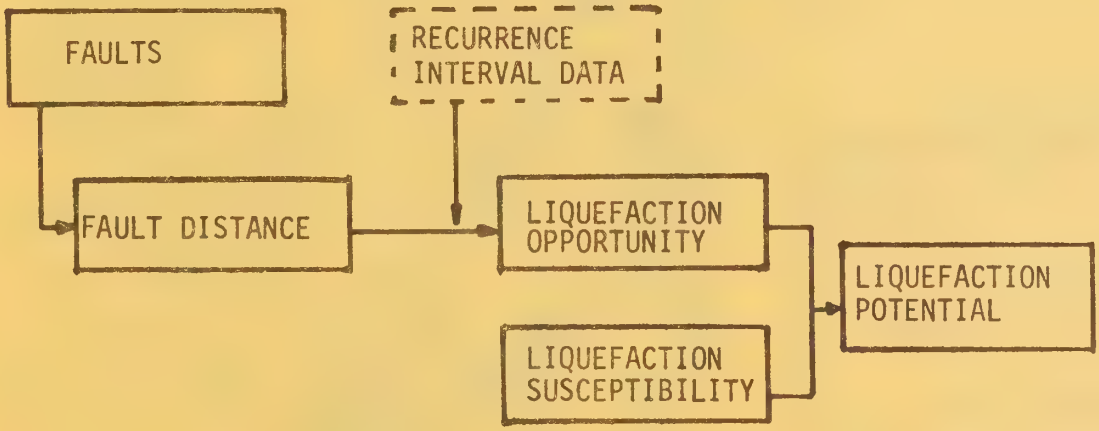
COVERAGE: All nine Bay Area counties

SOURCE: The hazard map file on liquefaction susceptibility and the basic data map file on faults are combined to produce this map using data on:

- o the relative susceptibility
- o the liquefaction opportunity (the frequency of earthquakes)
- o a formula relating magnitude to distance from fault for liquefaction

March 1980
Hectare resolution

DIAGRAM OF COMPONENTS:



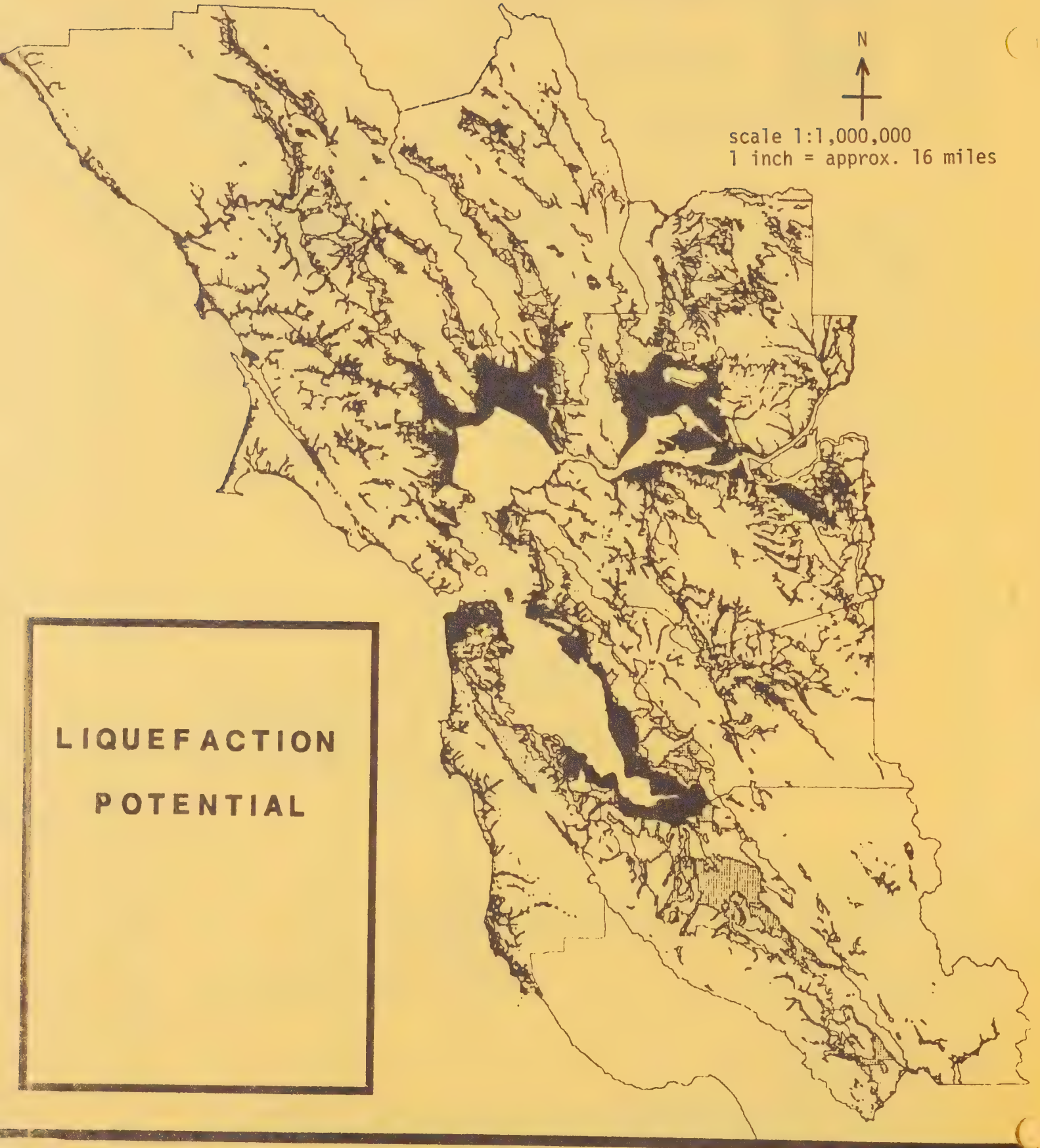
FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

- o Working Paper #4: Liquefaction Potential Mapping

The method is based on several publications of Les Youd and others of U.S.G.S.

LIMITATIONS AND FUTURE PLANS:

The difference in the detail of geology information between the central Bay Area and the rest of the region does not affect this file. Any improvements in the liquefaction susceptibility map would obviously improve this hazard map as well. Better information on earthquake recurrence intervals would improve the reliability of this file.



LIQUEFACTION POTENTIAL

BASIS BAY AREA SPATIAL INFORMATION SYSTEM

RAINFALL-INDUCED LANDSLIDE SUSCEPTIBILITY

HAZARD MAP FILE

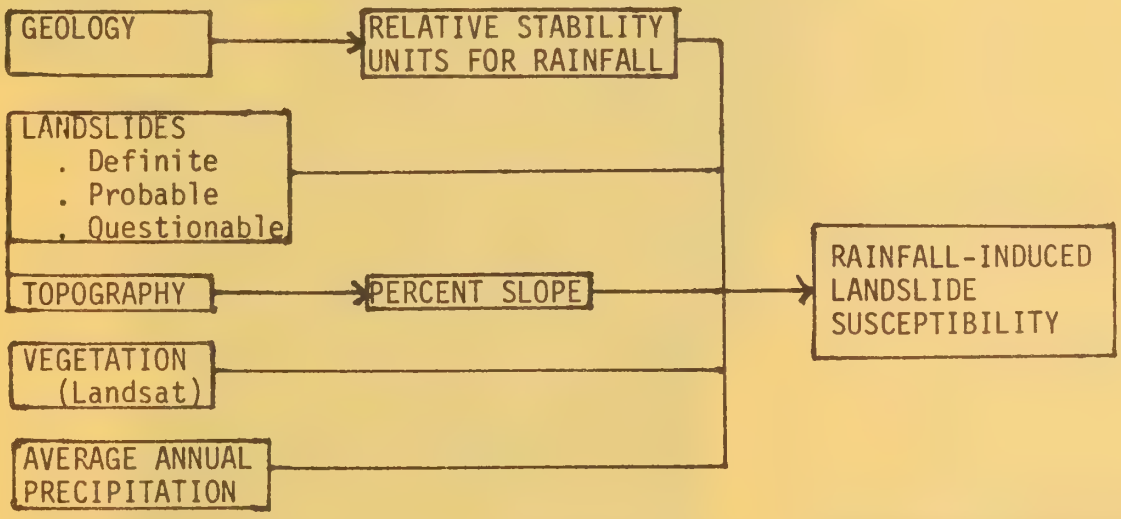
COVERAGE: The central Bay Area only
(Map on back covers San Mateo County)

June 1982
Hectare resolution

SOURCE: The basic data map files on geology, landslides, annual precipitation and vegetation type and topography (slope) are combined to produce this map using data on:

- o the surface extent of each geologic unit that has failed by landsliding
- o data on percent slope prior to failure
- o the surface extent of selected precipitation and vegetation categories that have failed

DIAGRAM OF COMPONENTS:



FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

- o Working Paper #5: Slope Stability Mapping
- o Working Paper #11: The Method Developed to Extend Detailed Map Information Beyond San Mateo County to Selected Areas of Significant Development Pressure.
- o Working Paper #16: Detailed Map Information for Selected Existing Urbanized Areas and Landslide Susceptibility Hazard Map Refinement

The method is based on research of Brabb and others at U.S.G.S.

LIMITATIONS AND FUTURE PLANS:

This file currently is available only for the central Bay Area. The landslide susceptibility mapping of Nilsen and others (U.S.G.S. Professional Paper 943) is available in BASIS but at 1/4 sq. km. resolution.

RAINFALL
INDUCED
LANDSLIDE
SUSCEPTIBILITY

BASIS

N

scale 1:250,000
1 inch = approx. 4 miles

EARTHQUAKE-INDUCED LANDSLIDE SUSCEPTIBILITY

HAZARD MAP FILE

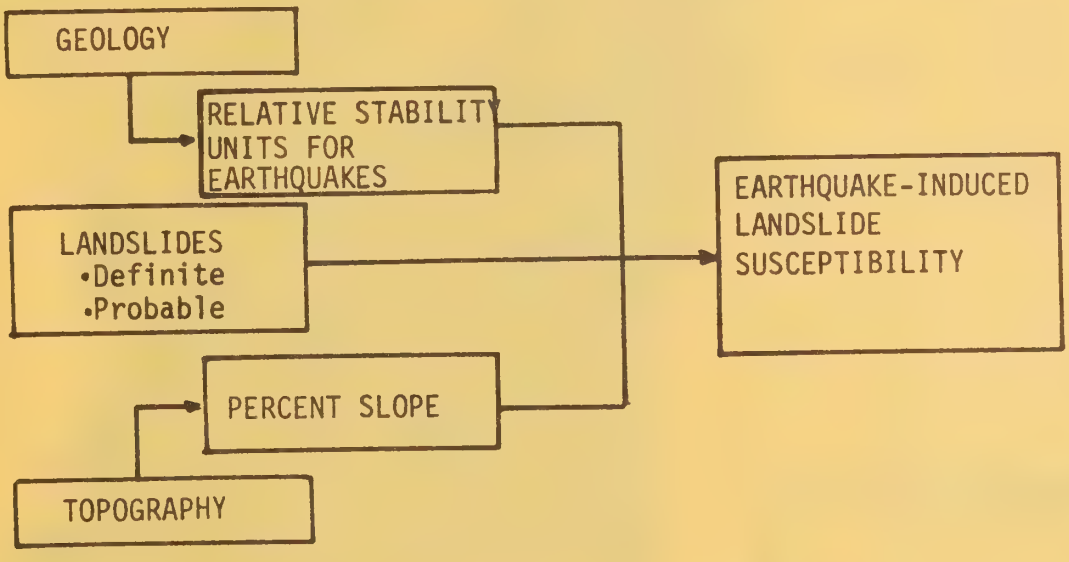
COVERAGE: The central Bay Area only
(Map on back covers San Mateo County)

June 1982
Hectare resolution

SOURCE: The basic data map files on geology, landslides and topography (slope) are combined to produce this map using data on:

- o physical properties of the geologic units (largely relative cohesion)
- o data on historic failures
- o data on saturation characteristics

DIAGRAM OF COMPONENTS:



FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

- o Working Paper #5: Slope Stability Mapping
- o Working Paper #11: The Method Developed to Extend Detailed Map Information Beyond San Mateo County to Selected Areas of Significant Development Pressure.
- o Working Paper #16: Detail Map Information for Selected Existing Urbanized Areas and Landslide Susceptibility Hazard Map Refinement.

The method is based on research of Wieczorek and others at U.S.G.S.

LIMITATIONS AND FUTURE PLANS:

This file currently is available only for the central Bay Area. At the present time, insufficient data is available on landslide opportunity to enable a landslide potential map to be created.

EARTHQUAKE INDUCED LANDSLIDE SUSCEPTIBILITY

BASIS

N

scale 1:250,000
1 inch = approx. 4 miles

FAULT SURFACE RUPTURE

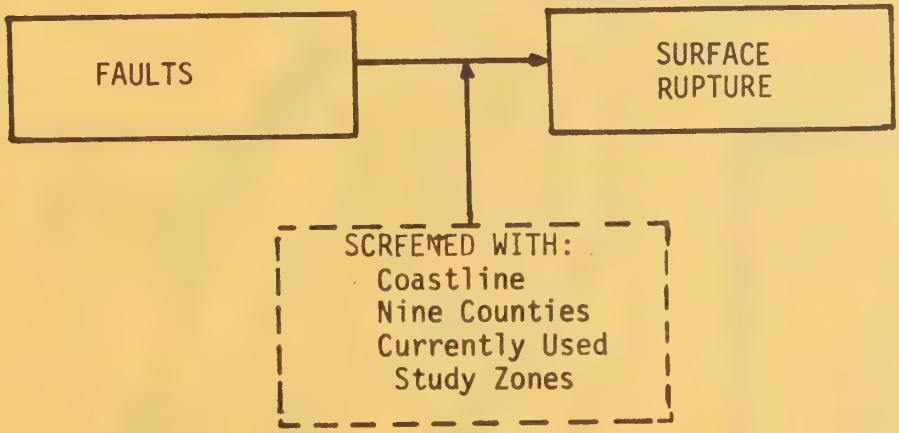
HAZARD MAP FILE

COVERAGE: All nine Bay Area counties

SOURCE: The basic data map file on faults is modified using data on:
- o fault activity from U.S.G.S. and C.D.M.G.
- o local government requirements

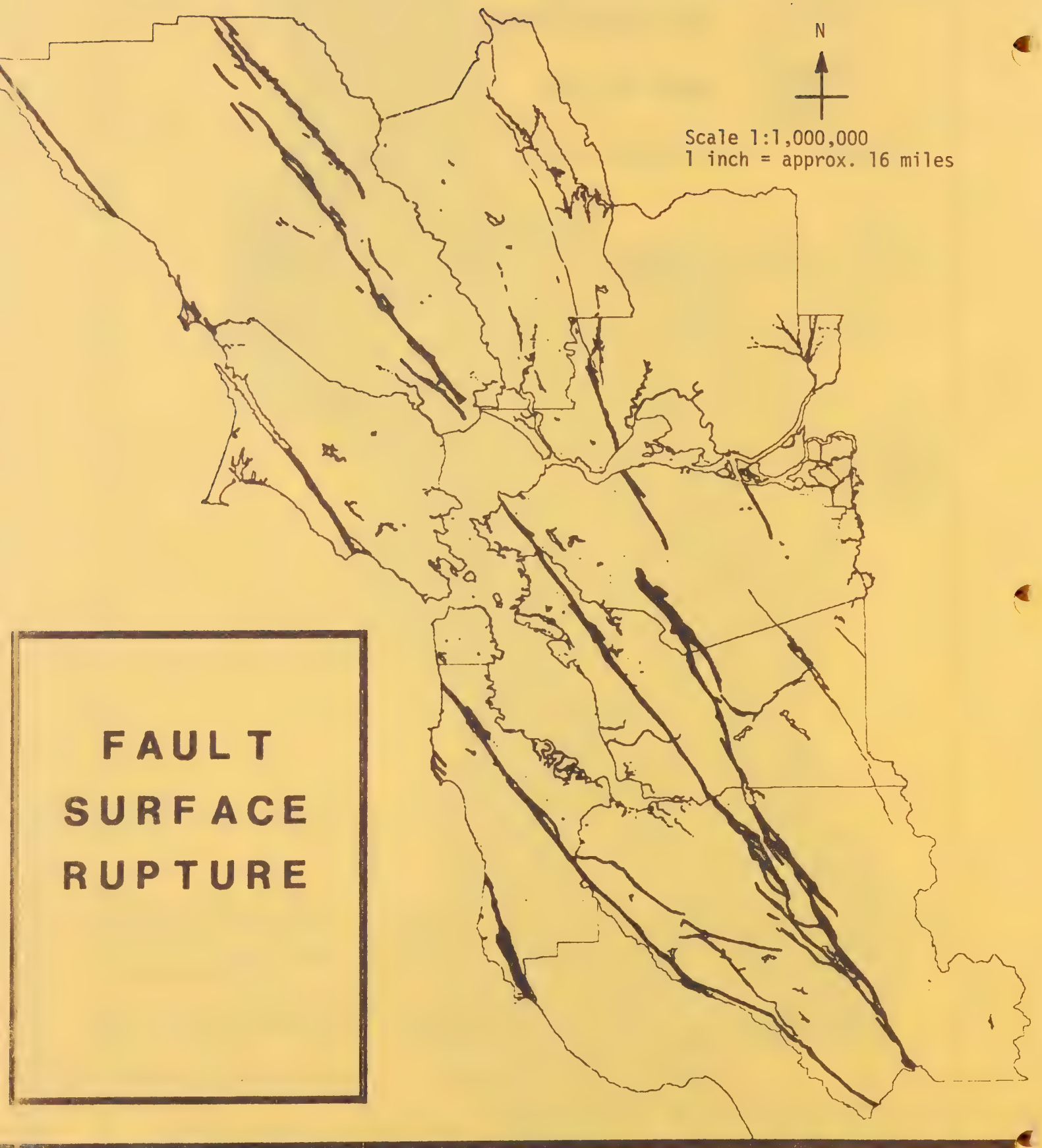
June 1982
Hectare resolution

DIAGRAM OF COMPONENTS:



FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:
- o Working Paper #9: Earthquake Map Applications for Composite Earthquake Hazard Mapping
- o Working Paper #17: Using Earthquake Intensity and Relative Damage to Estimate Maximum Earthquake Intensity and Risk of Ground Shaking Damage

LIMITATIONS AND FUTURE PLANS:
As new information on fault activity becomes available, both U.S.G.S. and C.D.M.G. staff will modify the maps used as a basis for this file. The hazard file will be modified accordingly.



FAULT SURFACE RUPTURE

BASIS BAY AREA SPATIAL INFORMATION SYSTEM

TSUNAMI HAZARD AREAS

HAZARD MAP FILE

COVERAGE: All nine Bay Area counties

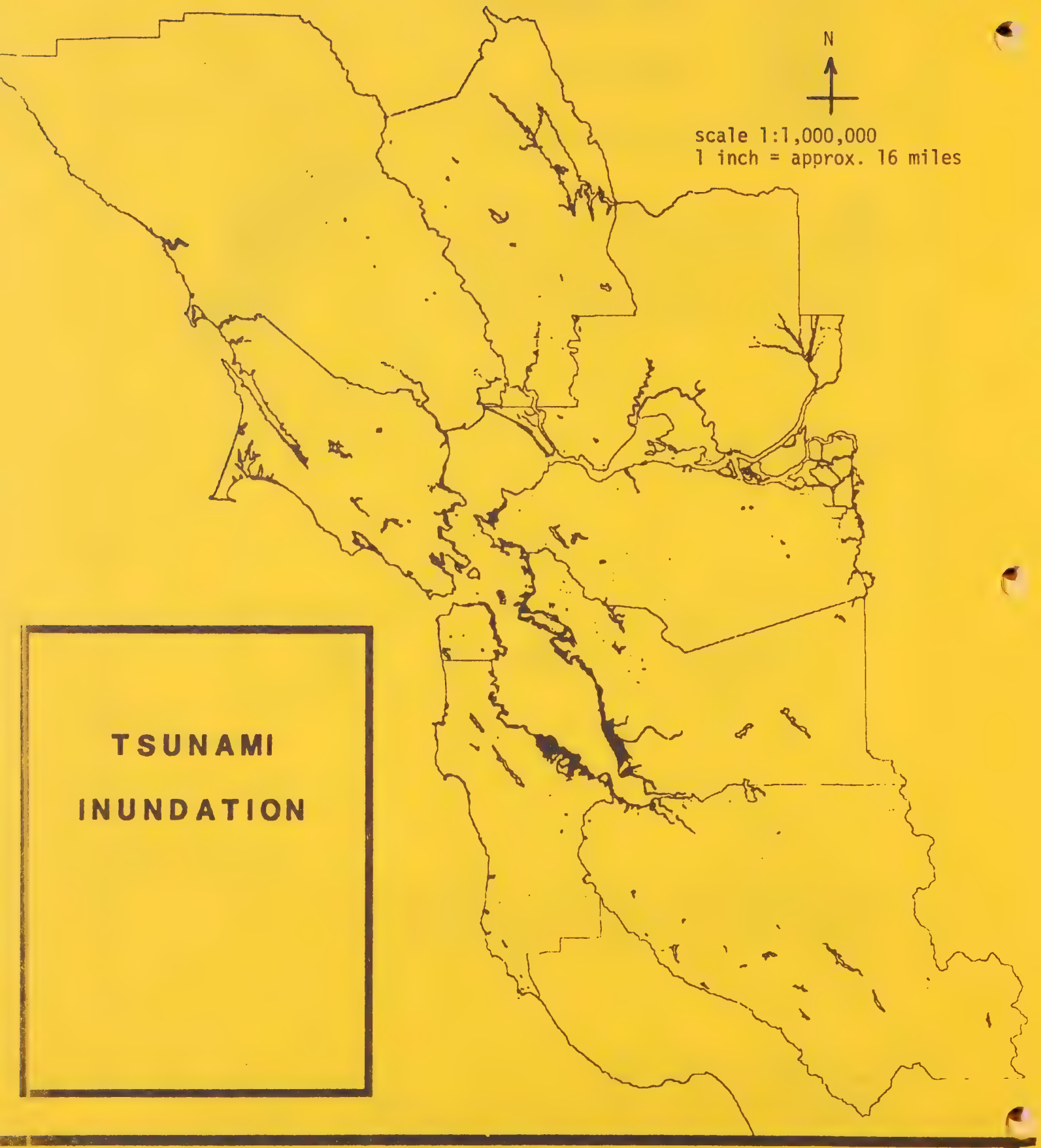
SOURCE: The basic data map file on tsunami inundation areas is currently the map of tsunami hazard areas. This file is included separately to emphasize that the file could have been created with information on topography and runup.

March 1980
Hectare resolution

DIAGRAM OF COMPONENTS:

FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:
o Working Paper #6: Tsunami Inundation Areas

LIMITATIONS AND FUTURE PLANS:
A more detailed map showing depth of inundation currently is not available in a usable form. However, special studies being done in conjunction with the Federal Flood Insurance Program should be available in the future. This file may be replaced with a file that combines data on runup, tsunami, recurrence, and elevation.



TSUNAMI INUNDATION

BASIS BAY AREA SPATIAL INFORMATION SYSTEM

DAM FAILURE HAZARD AREAS

HAZARD MAP FILE

COVERAGE: All nine Bay Area counties

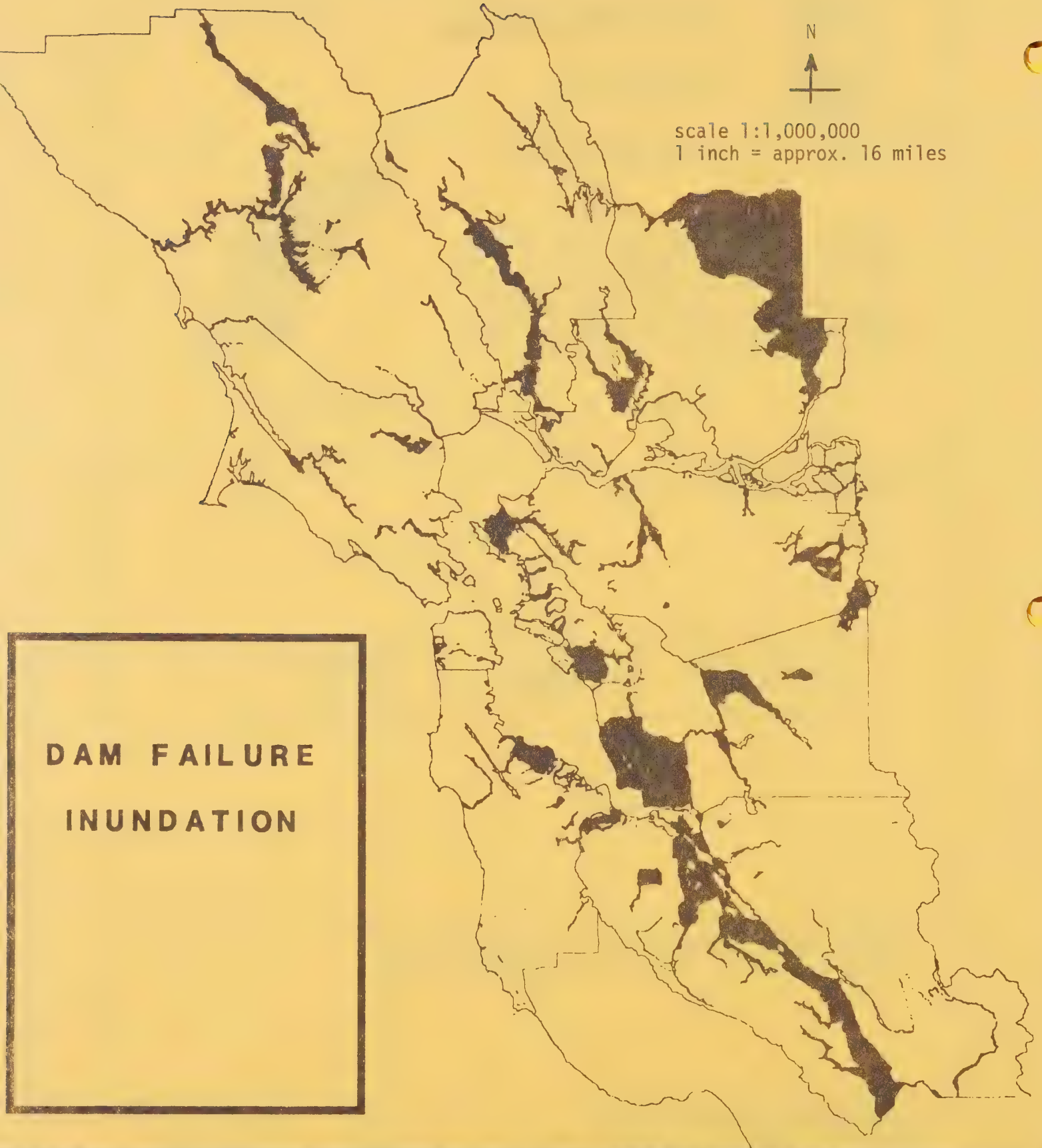
March 1980
Hectare resolution

SOURCE: The basic data map file on dam failure inundation areas is currently the map of dam failure hazard areas. This file is included separately to emphasize that the file could have been created with more basic information.

DIAGRAM OF COMPONENTS:

FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:
o Working Paper #7: Dam Failure Inundation Areas

LIMITATIONS AND FUTURE PLANS:
This file does not contain information on depth of inundation although this information is available from some dam owners. At the present time, little is known on the statistical recurrence of failure of dams, although one would expect that being exposed to earthquakes would increase this rate.



DAM FAILURE INUNDATION

BASIS BAY AREA SPATIAL INFORMATION SYSTEM

MAP FILE APPLICATIONS

As of June 1982, these map files can be manipulated for five different types of applications:

- o local general plans
- o computer assisted environmental assessment
- o production of composite hazard maps and site screening
- o assessment of current and projected property and population at risk
- o analysis of lifeline systems

Each of the following sheets consists of five major sections describing various aspects of the applications on the front and a sample of an application product on the back. The five sections include:

- o Coverage - the area of the region covered (including a map) and the resolution of the data
- o Source files - a list of the basic data map files and the hazard map files used
- o Description of product
- o Further information on this file is contained in - a list of the working papers further describing the map application
- o Limitations and future plans - limitations in coverage or accuracy are described, together with future plans to improve ABAG's ability to produce the products described

LOCAL GENERAL PLANS

MAP FILE APPLICATION

COVERAGE: All nine Bay Area counties with the central Bay Area in more detail

SOURCE FILES: Geology; Faults; Topography; Landslides; Tsunami Inundation Areas; Dam Failure Inundation Areas; Maximum Ground Shaking Intensity; Risk of Ground Shaking Damage; Liquefaction Susceptibility; Liquefaction Potential; Rainfall and Earthquake-Induced Landslide Susceptibility; Fault Surface Rupture

June 1982
Hectare resolution

DESCRIPTION OF PRODUCT:
One of the appropriate ways to use the mapped information is for identifying hazardous areas in a safety or seismic safety element of a local general plan. The latest State General Plan Guidelines for these elements recommend having several maps, most of which are available through ABAG's earthquake hazard mapping work. The table on the back of this page lists those maps available through ABAG that are recommended in the State Office of Planning and Research Guidelines. The cost of these maps depends on the quantity ordered and the map scale specified.

FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:
o Working Paper #12: Ordering and Using Earthquake Hazard Maps in Local General Plans

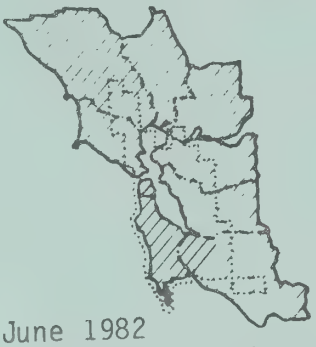
LIMITATIONS AND FUTURE PLANS:
Most maps are available for the entire region. However, the slope, slope aspect, landslide, landslide susceptibility and composite maps are only available for the central Bay Area at this time.

COMPUTER ASSISTED ENVIRONMENTAL ASSESSMENT

MAP FILE APPLICATION

COVERAGE: All nine Bay Area counties with the central Bay Area in more detail

SOURCE FILES: Geology; Faults; Topography; Landslides; Tsunami Inundation Areas; Dam Failure Inundation Areas; Maximum Ground Shaking Intensity; Risk of Ground Shaking Damage; Liquefaction Susceptibility; Liquefaction Potential; Rainfall and Earthquake-Induced Landslide Susceptibility; Fault Surface Rupture



June 1982
Hectare resolution

DESCRIPTION OF PRODUCT:
This application will produce a background document for development proposals that can be incorporated into the Environmental Impact Report (EIR). This document currently has eleven parts, each focusing on a different social or environmental concern. The part dealing with earthquake hazards is "Geology and Soils--Hazards and Resources". Each section, including the one on geology and soils, contains three parts--setting, impacts, and mitigation. The setting section contains information on five data items: topography, faults, landslides, geologic materials, and soil associations. The impacts section contains information on: rainfall-induced landslide susceptibility, earthquake-induced landslide susceptibility, liquefaction potential, tsunami inundation areas, dam failure inundation areas, maximum earthquake intensities, and earthquake intensity damage and risk. The mitigation section would include those items to be required of the developer by the city or county, including requirements for further study. An extensive list of possibilities is contained in Working Paper #13. The information for each section is presented on a single page. A copy of the impacts section for a hypothetical development is reproduced on the back of this sheet.

FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:
- o Working Paper #8 : Earthquake Map Applications for Automated Environmental Impact Assessment
- o Working Paper #13: Automated Environmental Impact Assessment - An Update

LIMITATIONS AND FUTURE PLANS:
At the present time, because of the limited coverage of the topography, landslide, and landslide susceptibility files, a complete report can be produced only for the central Bay Area. The coverage could be expanded should a city or county request the service and provide funds for file development.

****
* SWEENEY RIDGE: AUTOMATED ENVIRONMENTAL IMPACT ASSESSMENT *
****

GEOLOGY AND SOILS - HAZARDS AND RESOURCES

IMPACTS

MAXIMUM EARTHQUAKE INTENSITY

	AREA(HECTARES)
A (4)-VERY VIOLENT	0.
B (3)-VIOLENT	36.
C (2)-VERY STRONG	63.
D (1)-STRONG	242.
E (0)-WEAK	101.
NEGLIGIBLE	0.

RISK OF DAMAGE
EXPECTED RISK OF GROUND-SHAKING DAMAGE
FOR BUILDING TYPES PROPOSED FOR SITE
(ESTIMATE BASED ON STATISTICAL PROCEDURES
USING MAJOR FAULT EARTHQUAKE RECURRENCE
INTERVALS AND AVERAGE BUILDING DAMAGE)

		AREA(HECTARES)		
PRESENT VALUE OF PERCENT DAMAGE		WOOD FRAME DWELLINGS	CONCRETE/STEEL BUILDINGS	TILT-UP CONCRETE
0.0-1.0%	MODERATE	442.	406.	343.
1.1-2.0%	*	0.	34.	63.
2.1-3.0%	*	0.	2.	21.
3.1-4.0%	HIGH	0.	0.	13.
4.1-5.0%	*	0.	0.	2.
5.1-6.0%	*	0.	0.	0.
>6.0%	VERY HIGH	0.	0.	0.

LIQUEFACTION POTENTIAL

	AREA(HECTARES)
VERY LOW	442.
*	0.
*	0.
LOW	0.
*	0.
*	0.
MODERATE	0.

SLOPE STABILITY
RAINFALL-INDUCED
LANDSLIDE SUSCEPTIBILITY

	AREA(HECTARES)
STABLE	112.
*	316.
*	0.
*	0.
*	0.
*	0.
UNSTABLE	14.

EARTHQUAKE-INDUCED
LANDSLIDE SUSCEPTIBILITY

	AREA(HECTARES)
STABLE	294.
*	96.
*	21.
UNSTABLE	31.

TSUNAMI INUNDATION AREAS

	AREA(HECTARES)
INSIDE	0.
OUTSIDE	442.

DAM FAILURE INUNDATION AREAS

	AREA(HECTARES)
OUT OF DAM INUNDATE	442.

COMPOSITE HAZARD MAPS AND SITE SCREENING

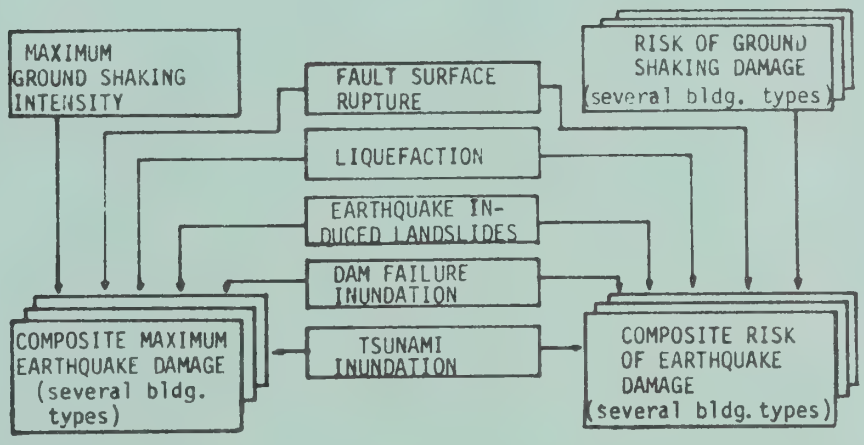
MAP FILE APPLICATION

COVERAGE: All nine Bay Area counties with the central Bay Area in more detail

SOURCE FILES: Maximum Ground Shaking Intensity; Risk of Ground Shaking Damage; Fault Surface Rupture; Liquefaction Susceptibility and Potential; Earthquake-Induced Landslide Susceptibility (and Potential when available); Tsunami Hazard Areas; and Dam Failure Hazard Areas

June 1982
Hectare resolution

DESCRIPTION OF PRODUCT:


MAXIMUM GROUND SHAKING INTENSITY
FAULT SURFACE RUPTURE
RISK OF GROUND SHAKING DAMAGE (several bldg. types)
LIQUEFACTION
EARTHQUAKE INDUCED LANDSLIDES
DAM FAILURE INUNDATION
TSUNAMI INUNDATION
COMPOSITE MAXIMUM EARTHQUAKE DAMAGE (several bldg. types)
COMPOSITE RISK OF EARTHQUAKE DAMAGE (several bldg. types)

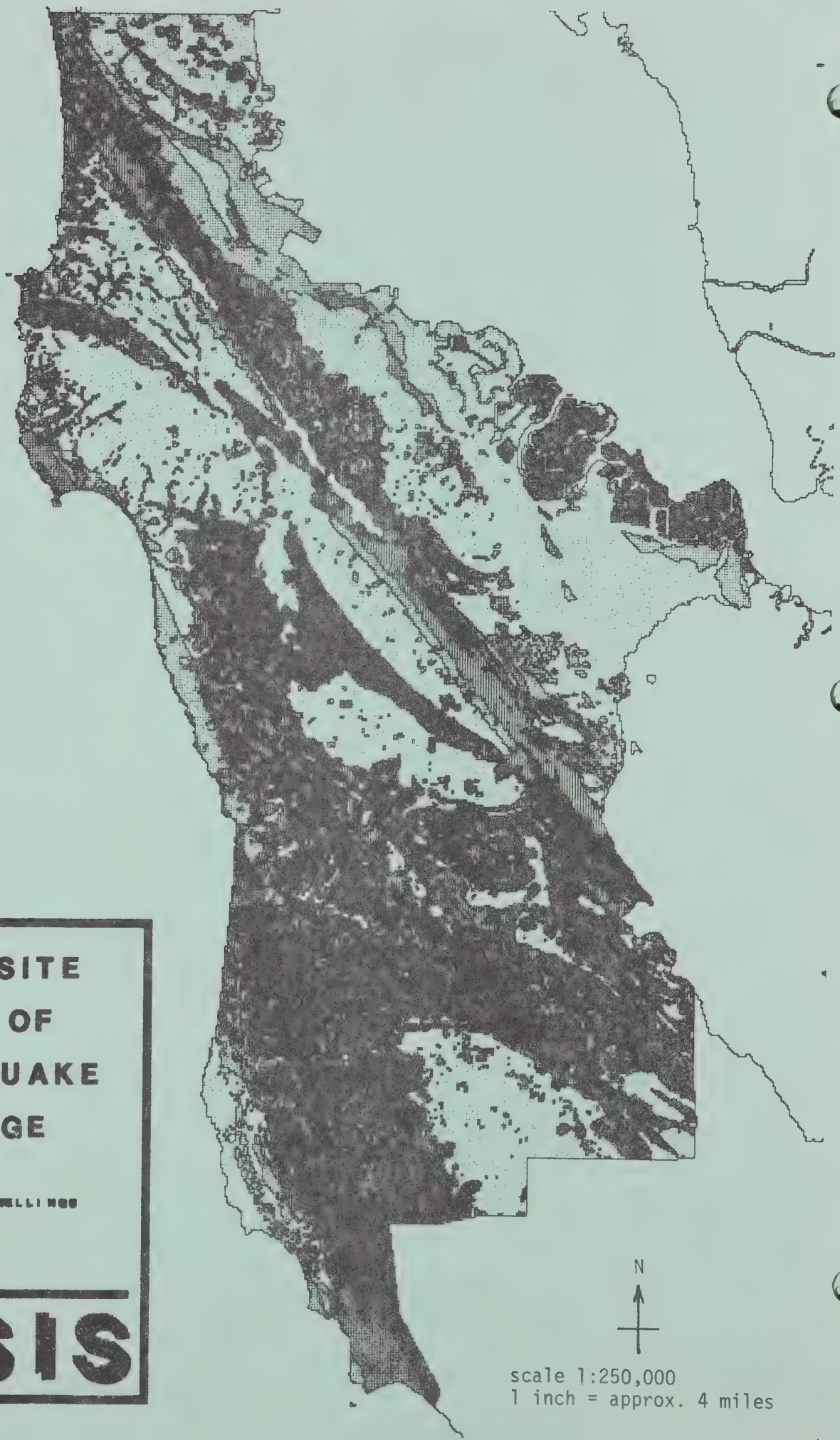
An example of a composite map appears on the reverse of this sheet. Uses for these maps are described in Working Paper #14.

FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

- o Working Paper #9: Earthquake Map Applications for Composite Earthquake Hazard Mapping
- o Working Paper #11: The Method Developed to Extend Detailed Map Information Beyond San Mateo County to Selected Areas of Significant Development Pressure
- o Working Paper #14: Using Earthquake Hazard Maps for Site Screening and Anticipating Mitigation Benefits and Costs

LIMITATIONS AND FUTURE PLANS:

Any composite maps that are produced at this time have two limitations. First, the landslide susceptibility file is only available for part of the region. Second, the lack of information on landslide opportunity in earthquakes makes the production of a landslide potential map impractical. The current data on damage associated with both landslides and liquefaction make composite maps only a rough estimate of areas that are relatively safe.



COMPOSITE RISK OF EARTHQUAKE DAMAGE

WOOD FRAME DWELLINGS

BASIS

N

scale 1:250,000
1 inch = approx. 4 miles

ASSESSMENT OF CURRENT AND PROJECTED PROPERTY AND POPULATION AT RISK

MAP FILE APPLICATION

COVERAGE: All nine Bay Area counties with San Mateo County in more detail

SOURCE FILES: This application can use any of the basic data map files or hazard map files together with the land use jurisdiction and census tract files.

June 1982
Hectare resolution

DESCRIPTION OF PRODUCT:
This application can produce tables of the amount of land in each hazard category on each hazard map file by:

- o Census tract
- o City sphere of influence
- o County
- o Land Use

An example of these types of tables is reproduced on the back of this sheet. Census tract data could be disaggregated by using the land use data to produce statistics on population at risk. Comparisons of existing and projected risk in San Mateo County have been made and indicate that areas of high potential for development are less hazardous than existing developed areas.

FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

- o Working Paper #10: Earthquake Map Applications for Automated Assessment of Property and Population at Risk
- o Working Paper #15: Assessment of Current and Projected Property and Population at Risk - An Update

LIMITATIONS AND FUTURE PLANS:
At the present time, the land use file is available only for San Mateo County so some of the more sophisticated applications only can be performed for that area. In addition, the extent of coverage of the data files may limit those areas where tables can be produced.

AREA (IN HECTARES) FOR CATEGORIES OF
TSUNAMI INUNDATION
BY JURISDICTION

JURISDICTION	WITHIN	OUTSIDE
Cities		
ATHERTON	0.	1294.
BELMONT	3.	1224.
BRISBANE	10.	554.
BURLINGAME	115.	1102.
COLMA	0.	481.
DALY CITY	0.	2210.
FOSTER CITY	987.	12.
HALF MOON BAY	168.	5606.
HILLSBOROUGH	0.	1682.
MENLO PARK	283.	2719.
MILLBRAE	13.	832.
PACIFICA	116.	3309.
PORTOLA VALLEY	0.	3307.
REDWOOD CITY	1042.	4837.
SAN BRUNO	0.	1526.
SAN CARLOS	0.	1760.
SAN MATEO	218.	3339.
SOUTH SAN FRANCISCO	173.	2320.
WOODSIDE	0.	5474.
Counties		
ALAMEDA	5478.	185588.
CONTRA COSTA	875.	187480.
MARIN	3592.	131332.
NAPA	1.	195672.
SAN FRANCISCO	915.	11154.
SAN MATEO	3554.	112770.
SANTA CLARA	267.	334459.
SOLANO	463.	218945.
SONOMA	890.	409651.
Regional Total		
BAY AREA	16035.	1783051.

AREA (IN HECTARES) FOR CATEGORIES OF
DAM FAILURE INUNDATION
BY JURISDICTION

JURISDICTION	WITHIN	OUTSIDE
Cities		
ATHERTON	111.	1183.
BELMONT	106.	1121.
BRISBANE	0.	564.
BURLINGAME	122.	1095.
COLMA	0.	481.
DALY CITY	0.	2210.
FOSTER CITY	999.	0.
HALF MOON BAY	159.	5615.
HILLSBOROUGH	196.	1486.
MENLO PARK	199.	2803.
MILLBRAE	0.	845.
PACIFICA	0.	3425.
PORTOLA VALLEY	70.	3237.
REDWOOD CITY	276.	5603.
SAN BRUNO	0.	1526.
SAN CARLOS	0.	1760.
SAN MATEO	1874.	1683.
SOUTH SAN FRANCISCO	0.	2493.
WOODSIDE	23.	5451.
Counties		
ALAMEDA	35088.	155978.
CONTRA COSTA	12709.	175646.
MARIN	2578.	132346.
NAPA	10821.	184852.
SAN FRANCISCO	460.	11609.
SAN MATEO	4529.	111795.
SANTA CLARA	38430.	296296.
SOLANO	56536.	158872.
SONOMA	15961.	394580.
Regional Total		
BAY AREA	177112.	1621974.

ANALYSIS OF THE VULNERABILITY OF LIFELINE SYSTEM LOCATIONS

MAP FILE APPLICATION

COVERAGE: All nine Bay Area counties

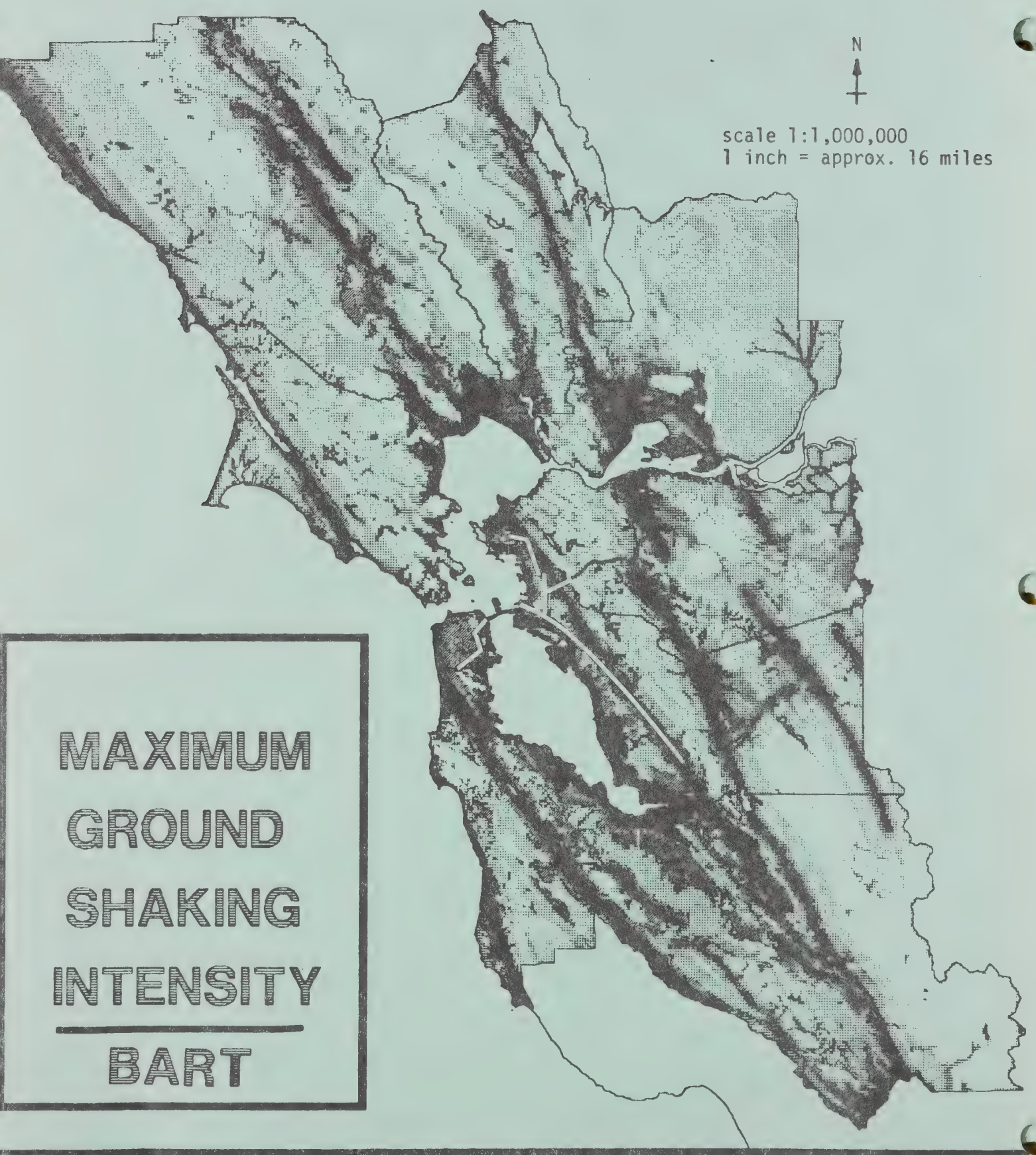
SOURCE FILES: This application can make use of any of the basic data map files or hazard map files together with the lifeline map files.

June 1982
Hectare resolution

DESCRIPTION OF PRODUCT:
In a sample application of this analysis technique, three main types of lifeline system components -- the networks, key facilities, and service areas -- were examined. The decision was made to concentrate on sewage, water supply, rail and highway systems. Less emphasis has been placed on air and water transportation, solid waste disposal and power systems. Analysis techniques used include area tabulations of hazard level by lifeline type on link, identification of points of concern on networks, a printout of hazards associated with the location of key facilities, and an assessment of hazard levels associated with utility service areas.

FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:
- Working Paper #18: Using Earthquake Hazard Maps to Analyze the Vulnerability of Lifeline System Locations

LIMITATIONS AND FUTURE PLANS:
Since the landslide susceptibility mapping is only available for the central Bay Area, tabulations of lifelines in these hazard areas can only be produced for the central Bay Area.



MAXIMUM GROUND SHAKING INTENSITY

BART

BASIS

BAY AREA SPATIAL INFORMATION SYSTEM

WORKING PAPERS
(as of June 1982)

The working papers referenced in this guide are not automatically included in this document. They can be ordered from ABAG's offices at a small charge. This user's guide, complete with all Working Papers, has automatically been forwarded to the planning director in each city and county in the Bay Area.

The available working papers include:

#1 - Faults and Ground Shaking Intensity -- replaced by Working Paper #17

#2 - Attenuation, Geologic Materials and Ground Shaking -- replaced by Working Paper #17

#3 - Damage and Ground Shaking Intensity -- replaced by Working Paper #17

#4 - Liquefaction Potential Mapping -- a description of the likelihood of finding cohesionless sediments within a geologic map unit, the likelihood that those sediments (when saturated) would be susceptible to liquefaction, the likelihood of finding those sediments saturated, and liquefaction opportunity (based on recurrence intervals of earthquakes and the distance from various faults at which liquefaction can occur)

#5 - Slope Stability Mapping -- a description of how slope, geology and existing landslides can be used to estimate landslide susceptibility in an earthquake and under more normal circumstances in San Mateo County

#6 - Tsunami Inundation Areas -- a description of the data used to develop a tsunami hazard map and of the relative risk associated with tsunamis

#7 - Dam Inundation Areas -- a description of dam inundation mapping and of the relative risk associated with dam failure

#8 - Earthquake Map Applications for Automated Environmental Impact Assessment -- a description of how hazard map files can be used to produce a background document for development proposals that can be incorporated into an Environmental Impact Report

#9 - Earthquake Map Applications for Composite Earthquake Hazard Mapping -- a description of how the various hazard maps can be combined to yield two types of hazard maps of total earthquake associated damage

#10 - Earthquake Map Applications for Automated Assessment of Property and Population at Risk -- a description of how tables of area in cities, counties, census tracts and land use types can be created for each hazard map category, as well as some sample tables with a discussion of the conclusions that can be formed. In addition, the feasibility of disaggregating census tract data on population using land use to create data on population at risk in various hazard categories is discussed.

#11 - The Method Developed to Extend Detailed Map Information Beyond San Mateo County to Selected Areas of Significant Development Pressure -- a description of the process used to select the areas of development pressure, the refinements and extensions of the geology, landslide, and topography files, and the extensions of the intensity maps, landslides susceptibility maps, and composite maps to the Petaluma and ridgelands areas. (The intensity map discussion is superceded by Working Paper #17).

#12 - Ordering and Using Earthquake Hazard Maps in Local General Plans -- a description of the types of maps available, their relationship to maps recommended for inclusion in local plans by the State Office of Planning and Research General Plan Guidelines, and the scale and form in which those maps are available

#13 - Automated Environmental Impact Assessment - An Update -- a description of the revised setting and impacts section and an extensive description of possible mitigation measures

#14 - Using Earthquake Hazard Maps for Site Screening and Anticipating Mitigation Benefits and Costs -- a description of the use of these maps for pointing to areas that should be easier to develop in a safe manner, as well as for warning of the costs associated both with potential damage and with necessary hazard mitigation

#15 - Assessment of Current and Projected Property and Population at Risk - An Update -- a description of tabulations of population at risk, rather than land area, the issues surrounding the development of a risk map based on existing building types, comparisons of various methods of estimating earthquake losses, and comparisons of existing and projected risk. San Mateo County is used as a study area.

#16 - Detailed Map Information for Selected Existing Urbanized Areas and Landslide Susceptibility Hazard Map Refinement -- a description of the methods for choosing those areas for additional detailed hazard mapping, extending the bedrock geology, landslide and topography files to them, and producing the landslide susceptibility maps for the central Bay Area

#17 - Using Earthquake Intensity and Related Damage to Estimate Maximum Earthquake Intensity and Risk of Ground Shaking Damage -- a description of the general data needed to produce the series of individual intensity maps and the additional data needed to combine these maps to produce either a maximum intensity map or maps showing risk of damage

#18 - Using Earthquake Hazard Maps to Analyze the Vulnerability of Lifeline System Locations -- a description of ABAG's use of its mapping capabilities to gather information on the location of hazardous areas relative to key lifeline system components

ABAG ASSOCIATION OF BAY AREA GOVERNMENTS

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Mailing Address:
P.O. Box 2050
Oakland, CA 94604

March 26, 1984

Dear colleague:

Enclosed are the latest set of revisions to "The Guide to ABAG's Earthquake Hazard Mapping Capability." Please use these sheets to update your copy of the "Guide."

One of the major products of our latest project has been a **series of maps** depicting the intensities to be expected from a major earthquake on ten different faults produced at a scale of 1:250,000 (1 inch = approx. 4 miles):

- the San Andreas;
- the San Andreas north of Bolinas;
- the San Andreas south of Bolinas;
- the Hayward;
- the Calaveras;
- the Calaveras north of the Hayward-Calaveras split;
- the San Gregorio;
- the Healdsburg-Rodgers Creek;
- the Concord-Green Valley; and
- the Maacama.

In addition, we have revised **Earthquake Mapping Paper #17**, "Using Earthquake Intensity and Related Damage to Estimate Maximum Earthquake Intensity and Cumulative Damage Potential from Earthquake Ground Shaking." Six revised maps are available as part of that report (at a scale of 1:250,000 or 1 inch = approx. 4 miles):

- geology;
- fault traces used in the ground shaking models;
- maximum ground shaking intensity; and
- cumulative damage potential from earthquake ground shaking for
  - wood-frame dwellings,
  - most concrete and steel frame buildings, and
  - tilt-up concrete buildings.

Finally, we produced four additional maps at 1:250,000 that were previously only available at 1:500,000:

- Alquist-Priolo Special Studies Zones (for fault surface rupture);
- liquefaction susceptibility;
- liquefaction potential; and
- dam failure inundation areas.

Due to the cost of producing these large (3 1/4 ft. wide x 3 3/4 ft. high) maps, we are not supplying them unless requested. Please use the attached form to place your order. We have a limited printing budget and therefore may not be able to fill all orders without charge. ABAG's members will have first priority in receiving the maps and report for free. We will fill remaining orders by billing you the $2/item + $3/order handling charge noted, if requested. The fault trace map included with this letter should help you to determine which earthquake intensity maps would be appropriate to order for your area of interest. Orders for free maps must be received by Friday, April 13th.

We are pleased to report that we have just received a grant from the National Science Foundation to develop a regional occupancy and building inventory for the San Francisco Bay Area. This work will enable us to provide estimates of casualties and property losses for selected earthquake events.

If you have any questions, don't hesitate to call me on my direct dial line (415) 464-7934.

Sincerely,

Jeanne B. Perkins

Jeanne B. Perkins
Earthquake Preparedness Program Manager

enclosures

A GUIDE TO

ABAG'S

EARTHQUAKE HAZARD MAPPING

CAPABILITY

INSTITUTE OF GOVERNMENTAL
STUDIES LIBRARY

MAR 27 1984

UNIVERSITY OF CALIFORNIA

REVISED DECEMBER 1983

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ACKNOWLEDGEMENTS:

We would like to thank those many people at USGS and working for cities and counties in the Bay Area who took the time to review the many papers that form the basis for this guide.

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Introduction. . . . . White
Basic Data Map Files. . . . . Yellow
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Map File Applications . . . . . Green
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INTRODUCTION

PURPOSE

Since February 1979, ABAG has been developing a series of computer-based map files showing various basic data maps related to earthquakes and several maps derived from those illustrating various earthquake hazards. The project was started for two reasons:

- o to provide information that could be used by local governments in their seismic safety and safety programs.
- o to provide an input to various other planning programs at ABAG.

FORMAT

This project, unlike many that result in the publication of a final report, will be continuing and various map files will be expanded or upgraded. Therefore, this guide has been designed as a loose-leaf folder so that pages or sections can be replaced or added as ABAG's earthquake hazard mapping capability changes and expands.

The guide contains this introduction and three main sections:

- o a set of sheets describing each of the basic data map files and a cover sheet for that section
- o a set of sheets describing each of the hazard map files and a cover sheet for them.
- o a set of sheets describing several applications for the map files (also with a cover sheet).

The guide has also been designed to include a set of the working papers that have been developed to further describe the assumptions that were made and the data used to develop the hazard maps. A sheet summarizing the Working Papers is at the end of the report.

MAP DEVELOPMENT PHASES

The first phase of the mapping project focused on developing an operational earthquake hazard mapping capability and demonstrating some sample uses for researchers and local government technical staff. Files of basic data maps on generalized geology (four bedrock categories), faults, and dam failure and tsunami inundation areas were compiled for the entire nine-county Bay Area. Detailed information on hillside geology, as well as data on landslide deposits and topography, were compiled only for San Mateo County due to the expense of entering these data into the computer system. These basic data map files were manipulated to produce a series of hazard map files for the region or San Mateo County; including:

- o maximum ground shaking intensity;
- o cumulative risk of damage from ground shaking;
- o liquefaction susceptibility, both earthquake-induced and rainfall-induced;
- o dam failure and tsunami inundation; and
- o composite maps combining all these hazard maps.

The detailed ground shaking maps, landslide susceptibility maps and composite maps were produced only for San Mateo County.

The second phase expanded the area for which detailed hillside geology, landslide deposits and topographic information is in ABAG's computer data base by fifteen 7 1/2 minute quadrangles. These areas--Petaluma and its vicinity, and parts of the east Bay ridgelands of Santa Clara, Alameda and Contra Costa counties--were chosen as areas subject to extensive development pressure. The detailed basic data maps were used to develop more refined maximum ground shaking and risk maps, landslide susceptibility maps, and composite maps. These maps, together with those developed in the first contract, then were used in sample applications in local general plans, to provide computer-derived background reports for Environmental Impact Reports (EIRs), to screen areas for possible sites for key facilities, and to assess the vulnerability of existing and projected land uses and population to damage from a major earthquake.

The third phase focused on lifeline networks in the Bay Area, including major highways and railroads, electrical and gas networks, water supply aqueducts, and solid waste systems. Since lifeline problems are located largely in areas of existing urban development, this work is a logical complement to the second phase work, which focused on areas subject to rapid new development. Detailed information on hillside geology, landslide deposits, and topography was added to ABAG's computer data base for fifteen additional quadrangles in the central Bay Area. Again, the detailed basic data maps were used to develop more refined maximum ground shaking and risk maps and landslide susceptibility maps. These maps then will be used to provide detailed information on physical hazards, not structural hazards, associated with the location of these lifeline systems. The audience for these products is being broadened to include people and agencies operating and regulating lifeline systems, as well as local government staff.

The fourth and most recent phase of the mapping has sought to correct some major inadequacies of previous work. Therefore, ABAG has expanded the area for which detailed mapping of geological materials is available in digital form to cover all nine Bay Area counties. In addition, fault trace and fault study zone mapping available in July 1983 has been incorporated into ABAG's existing computer files of these data. The fault and geology files then have been combined with seismologic data on ground shaking attenuation, the effects of local geology on intensity, and the recurrence intervals of major earthquakes to refine the ground shaking risk maps produced in earlier phases, as well as to produce a

series of intensity maps for selected earthquake events. Finally, a series of maps showing hazards associated with liquefaction, dam failure and tsunami inundation (based on work in previous project phases) similar in format to the ground shaking intensity maps has been produced at a scale appropriate for most users for comparison with those intensity maps. ABAG has continued its successful program of extensive documentation and user interaction to ensure the continued and appropriate use of these maps by federal, state and local government, other ABAG programs, transportation and utility groups, and the private sector.

EARTHQUAKE MAPPING AND ABAG'S EARTHQUAKE PREPAREDNESS PROGRAM

ABAG'S concerns about earthquake safety grew out of three separate, but related, programs. ABAG served as a liaison with other regional planning agencies and with county and local governments in the San Francisco Bay Region Environment and Resources Planning Study. The study, begun in January 1970, was jointly sponsored by the U.S. Geological Survey and the Department of Housing and Urban Development. ABAG completed a report for this study in February 1976, Quantitative Land Capability Analysis - A Method of Applying Earth Science Information to Planning and Decision Making. The report describes the use of benefit-cost analysis in weighing the relative importance of selected earth science hazards, constraints and resources. The report was published as U.S.G.S. Professional Paper 945 in 1979.

During the same period, ABAG prepared a booklet entitled Hazards Evaluation for Disaster Preparedness Planning summarizing the results of a study on evaluating hazards sponsored by the Defense Civil Preparedness Agency of the Department of Defense, completed in August 1975. The project focused on developing a standard method for evaluating earthquakes and several other natural and man-made sources of disasters.

The findings of these reports, as well as other related information, were given to ABAG's member governments in February, 1976 at a General Assembly entitled "On Shaky Ground". ABAG's General Assembly indicated that a program to help prepare the region for coping with major earthquakes is extremely important. Such a program also has been supported by ABAG's Executive Board, Work Program and Coordination Committee and various other committees.

These desires led to the revision of ABAG's General Plan to include several objectives dealing with improving seismic safety and a series of actions to accomplish these objectives focusing on:

- o incorporating seismic safety concerns into ABAG's plan and project review function
- o supporting or advocating legislation at the State and federal level

- o providing assistance to ABAG's member governments in improving their safety and seismic safety programs

The service activities have led to several recent projects, including:

- o a survey of local regulations related to geologic and hydrologic hazards, constraints and resources
- o a survey of geotechnical study costs
- o a review of earthquake insurance issues
- o an extensive review of the liability of local government, as well as businesses and industries, for earthquake hazards and losses

The study of local government liability also resulted in ABAG's advocacy of State legislation that was passed by the legislature and signed by the Governor in 1979.

This earthquake mapping project is providing strong technical support for the Earthquake Preparedness Program. It is enabling ABAG staff to conduct land capability type analyses not only for all nine Bay Area counties, but also at the fine resolution of one hectare (2-1/2 acres).

These overlaying and modeling capabilities are extremely important not only for creating the hazard maps in the first place, but also for combining earthquake hazard concerns with other physical and social constraints for site evaluation and impacts analyses.

EARTHQUAKE MAPPING AND THE BAY AREA SPATIAL INFORMATION SYSTEM (BASIS)

This project is closely tied to ABAG's BASIS program. A major objective of BASIS is to develop a regional geographic data base that can be directly used in local, as well as regional, planning applications. It was developed to tie together the data development and map analysis different computers and different resolutions. (The land capability study that used a system at the University of California at Davis was one such application.)

BASIS is structured around an array of grid cells, each representing a land area of one hectar (100 meters square) in the UTM coordinate system. It requires over two million of these cells to cover the nine-county Bay Region. Each cell on the ground corresponds to one unit of computer storage; the unit contains data codes representing the characteristics of that cell. Data can be acquired either by reading a tape or by digitizing a map. BASIS is capable of using data based on other coordinated systems (such as longitude/latitude or LANDSAT reference points) by mathematically transforming these reference systems to a common UTM base. This project greatly increases the data available for each cell. The basic data map files listed in the main body of this guide are a product of direct data acquisition.

Much of the power of BASIS lies in its ability to manipulate the basic data map files. A composite of many data sets can be produced through an overlay or modeling process, and can include distance searches or other calculations. Most of the hazard map files are the product of these processes.

BASIS currently runs on Geogroup Corporation's computer system, which can handle data transfer to or from most other computer systems. The computer configuration includes a digitizer for encoding mapped data, an electrostatic plotter for producing computer maps, a small format 8-color pen plotter, and a printer. The present computer system (developed by Convergent Technologies) is a cluster of two work stations, each of which contains a processor and 256K bytes of memory. Data storage is presently on one 20M byte disk. A nine-track tape drive and standard floppy disks are used for file back-up and data transfer. Geogroup staff are responsible for all programming work.

BASIS DATA MAP FILES

As of December 1983, the earthquake hazard maps are based on six basic data map files described on the following pages:

- o geology (ozalid copies available at 1:250,000)
- o fault traces (ozalid copies available at 1:250,000)
- o topography
- o landslides
- o tsunami inundation areas
- o dam failure inundation areas (ozalid copies available at 1:250,000)

In addition, a land use file, and files of selected lifeline systems, have been created to illustrate some applications.

Each of the following sheets consists of five major sections describing various aspects of the map file on the front. The five sections include:

- o Coverage - the area of the region covered (including a map) and the resolution of the data
- o Source - the scale and name of the source used (if many sources are used a working paper containing the complete list may be referenced)
- o Major categories on map - the categories in the file are listed to the extent practicable
- o Used with other files to produce hazard files on - a cross-reference to the hazard map files using this basic data file
- o Limitations and future plans - limitations in coverage or accuracy are described, together with future plans to upgrade each file

A 1:1 million scale reproduction of the file appears on the back for illustration only. At this scale, a complete map explanation would be meaningless. Potential users should contact ABAG staff to obtain maps of their area of interest and an explanation for those maps.

There are other basic files in BASIS that have not been improved in conjunction with this earthquake mapping project. These files can be divided into two categories, files depicting the physical environment and those depicting the social environment:

PHYSICAL ENVIRONMENT

- o average annual precipitation - region-wide
- o vegetation - region-wide
- o National Flood Insurance Program maps - unincorporated areas and some cities
- o flood-prone areas defined by U.S.G.S. in 1972 - region-wide
- o coastline features from U.S.G.S. 7-1/2 minute quadrangles - region-wide
- o soil associations (generalized from soils types) - region-wide
- o average yield from wells - region-wide
- o digital terrain tape elevations - region-wide
- o slope stability (generalized to 25 hectare resolution) - region-wide
- o air quality problem areas - region-wide

SOCIAL ENVIRONMENT

- o 1970 census tracts - region-wide (1980 census tracts are available for selected applications)
- o county boundaries - region-wide
- o city sphere-of-influence boundaries - region-wide
- o airports, seaports, vacant industrial lands - region-wide
- o landfill sites and service areas

GEOLOGY

BASIC DATA MAP FILE

COVERAGE: All Bay Area counties in great detail

SOURCE:
SCALE: 1:62,500 and 1:24,000 (for bedrock geology) and 1:125,000 (for flatlands deposits)
NAME: U.S.G.S. Professional Paper 944--Flatlands deposits of the S.F. Bay Area; Geology Maps by various U.S.G.S. and C.D.M.G. authors (see Working Paper #17 for more information).

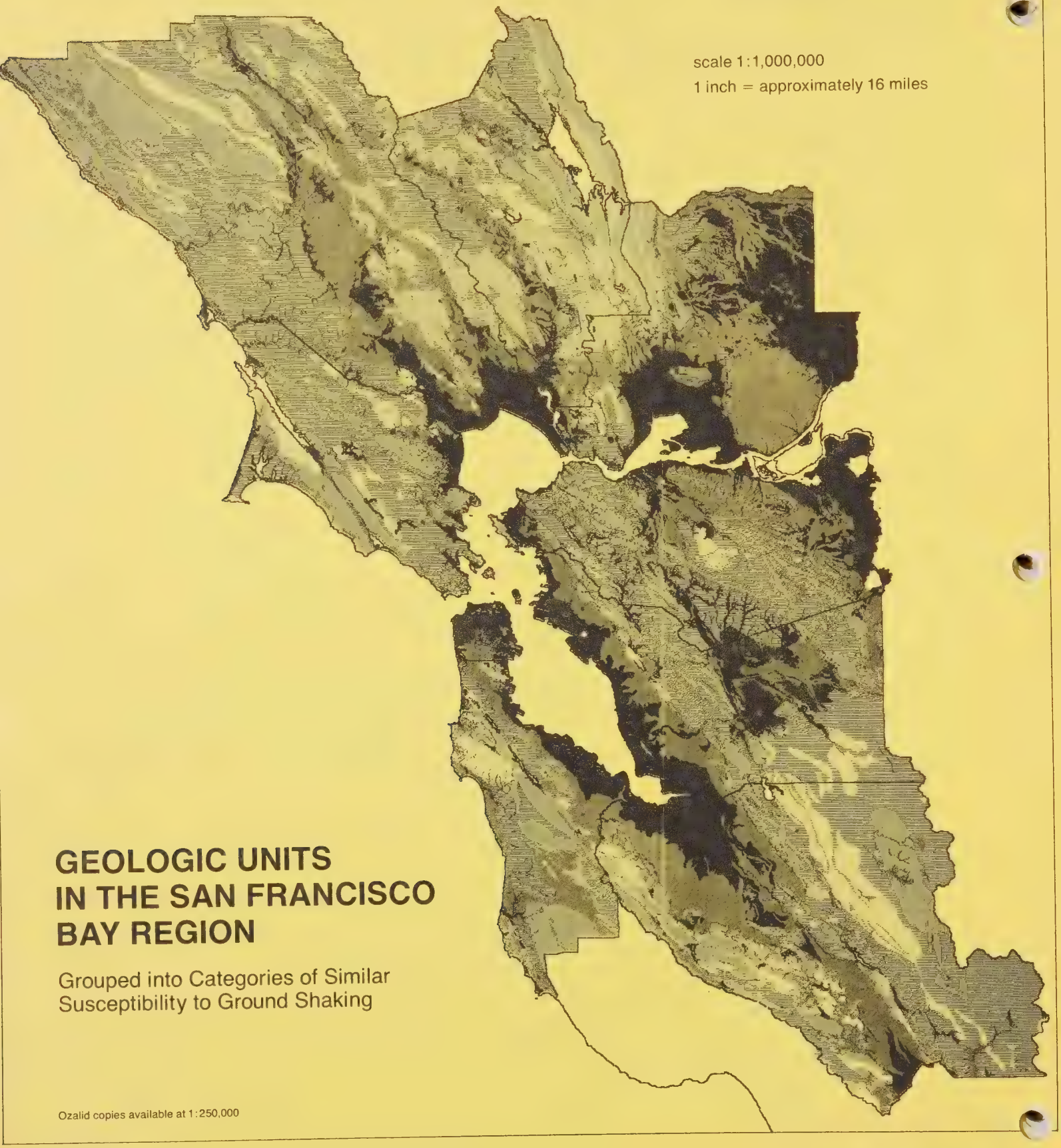
December 1983
Hectare resolution

MAJOR CATEGORIES ON MAP:
277 units, including:
- 26 Quaternary units (from the map of flatlands deposits);
- 16 Quaternary/Tertiary units
- 50 Tertiary (Pliocene) units
- 6 Tertiary (Pliocene/Miocene) units
- 20 Tertiary (Miocene) units
- 9 Tertiary (Miocene/Oligocene) units
- 5 Tertiary (Oligocene) units
- 29 Tertiary (Eocene) units
- 2 Tertiary/Eocene/Paleocene) units
- 10 Tertiary (Paleocene) units
- 8 Tertiary (Paleocene)/Cretaceous units
- 44 Cretaceous Units
- 22 Cretaceous/Jurassic units (largely Great Valley Sequence)
- 31 Cretaceous/Jurassic units (Franciscan Assemblage and small masses)

(These units have been grouped into 8 categories with similar seismic properties to produce the map on the back of this sheet. Darker shades are associated with units having a higher susceptibility to strong ground shaking.)

USED WITH OTHER FILES TO PRODUCE HAZARD FILES ON:
- o ground shaking intensity for selected scenario earthquakes
- o maximum ground shaking intensity
- o cumulative damage potential from earthquake ground shaking
- o liquefaction susceptibility and potential
- o rainfall-induced landslide susceptibility
- o earthquake-induced landslide susceptibility

LIMITATIONS AND FUTURE PLANS:
The geology file currently available is the state-of-the-art composite map for the San Francisco Bay Area.



scale 1:1,000,000
1 inch = approximately 16 miles

GEOLOGIC UNITS IN THE SAN FRANCISCO BAY REGION

Grouped into Categories of Similar Susceptibility to Ground Shaking

Ozalid copies available at 1:250,000

BASIS
Bay Area Spatial Information System

ABAG
ASSOCIATION OF BAY AREA GOVERNMENTS

FAULT TRACES

BASIC DATA MAP FILE

COVERAGE: All Bay Area counties and parts of adjacent counties

SOURCE:
SCALE: largely 1:24,000 with some at 1:60,000, 1:125,000, and 250,000
NAME: Fault traces shown on Special Studies Zones Maps prepared by the State Geologist and additional mapping of fault traces by U.S.G.S. personnel of faults they consider active or probable active. (See Working Paper #17 for more information.

December 1983
Vector(line) resolution

MAJOR CATEGORIES ON MAP:

Antioch
Berrocal
Butano*
Calaveras
Concord
Cordelia
Coyote Creek
Dunnigan Hills
East of Santa Rosa
East of Bennett Valley
Evergreen
Faults near Trenton
Green Valley (incl. Hunting Creek)
Greenville
Hayward (including Cressly)
Healdsburg
Las Positas
Maacama
Midway
Monte Vista
Ortigalita
Piercy
Pleasanton
Rodgers Creek
San Andreas
San Gregorio
San Joaquin
Sargent
Serra
Shannon*
Silver Creek
Tolay
Verona
West Napa
Zayante

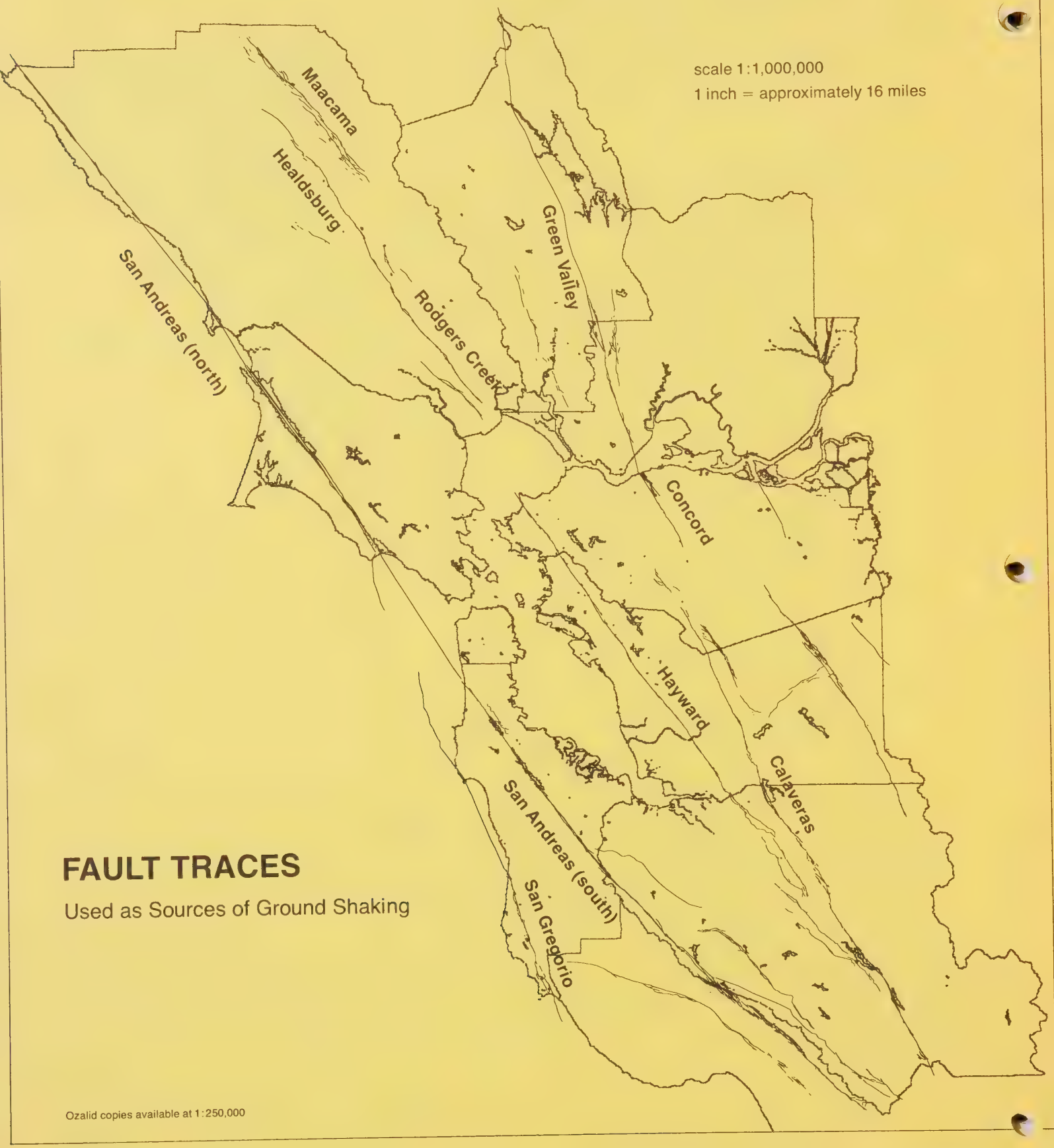
* Traces NOT included in intensity mapping and thus not shown on the back of this sheet.

USED WITH OTHER FILES TO PRODUCE HAZARD FILES ON:

- o ground shaking intensity for selected scenario earthquakes
- o maximum ground shaking intensity
- o cumulative damage potential from earthquake ground shaking
- o liquefaction potential
- o fault studies zones

LIMITATIONS AND FUTURE PLANS:

Changes in fault traces should be made as new information becomes available.



FAULT TRACES

Used as Sources of Ground Shaking

Ozalid copies available at 1:250,000

BASIS

Bay Area Spatial Information System

ABAG

ASSOCIATION OF BAY AREA GOVERNMENTS

HAZARD MAP FILES

As of December 1983, the first six basic data maps have been manipulated to create nineteen hazard map files and two of the basic maps (marked with *) are actually hazard files:

- o ground shaking intensity for ten selected scenario earthquakes (ozalid copies available at 1:250,000)
- o maximum ground shaking intensity (ozalid copies available at 1:250,000)
- o cumulative damage potential from earthquake ground shaking for three building types (ozalid copies available at 1:250,000)
- o liquefaction susceptibility (ozalid copies available at 1:250,000)
- o liquefaction potential (ozalid copies available at 1:250,000)
- o rainfall-induced landslide susceptibility
- o earthquake-induced landslide susceptibility
- o fault studies zones (ozalid copies available at 1:250,000)
- o *tsunami hazard areas
- o *dam failure hazard areas (ozalid copies available at 1:250,000)

Each of the following sheets consists of five major sections describing various aspects of the map files on the front. The five sections include:

- o Coverage - the area of the region covered (including a map) and the resolution of the data
- o Source - the basic data map files and the key assumptions used
- o Diagram of components a figure depicting how the basic data basic data map files are used to create the hazard map files
- o Further information on this file is contained in - a list of the working papers further describing the map development and, if applicable, other relevant documents (complete citations are not provided but can be obtained from the working papers)
- o Limitations and future plans - descriptions of limitations in coverage or accuracy, and any plans to upgrade the file.

A 1:1 million scale reproduction of the file appears on the back of each sheet. At this scale, an explanation of individual map categories is meaningless. Potential users should contact ABAG staff to obtain specially produced maps of their area of interest, any of the ozalid maps listed above, and an explanation for those maps.

GROUND SHAKING INTENSITY FOR SELECTED EARTHQUAKES

HAZARD MAP FILE

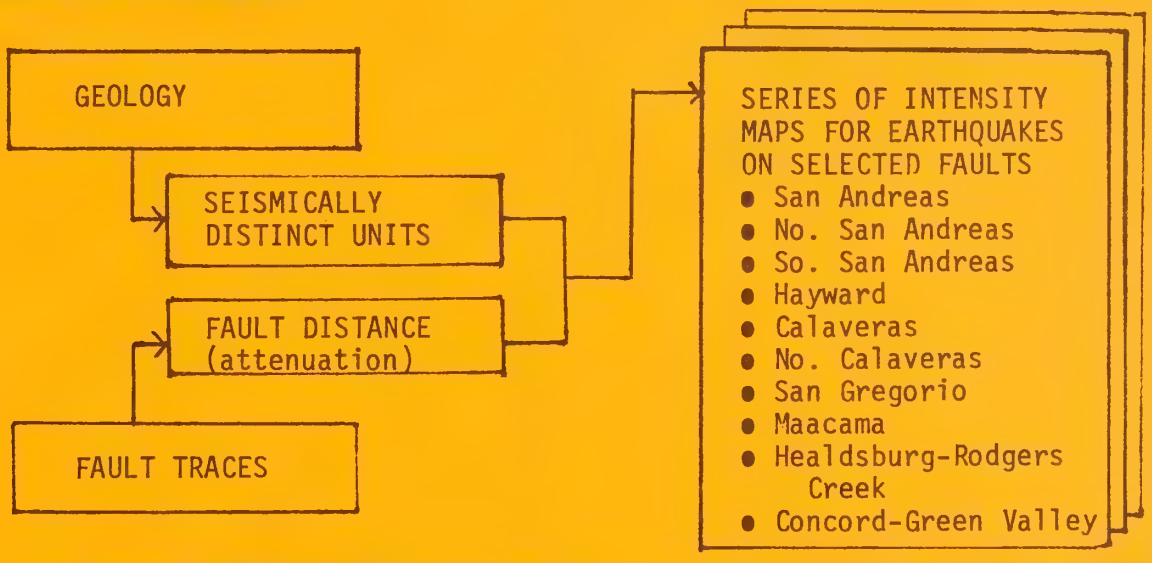
COVERAGE: All nine Bay Area counties in great detail

SOURCE: The basic data map files on faults and geology are combined to produce this map using data on:

- o magnitude associated with the source faults
- o maximum intensity associated with each magnitude
- o the attenuation of intensity with distance from the fault rupture
- o the effect of local geology on that intensity

December 1983
Hectare resolution

DIAGRAM OF COMPONENTS:



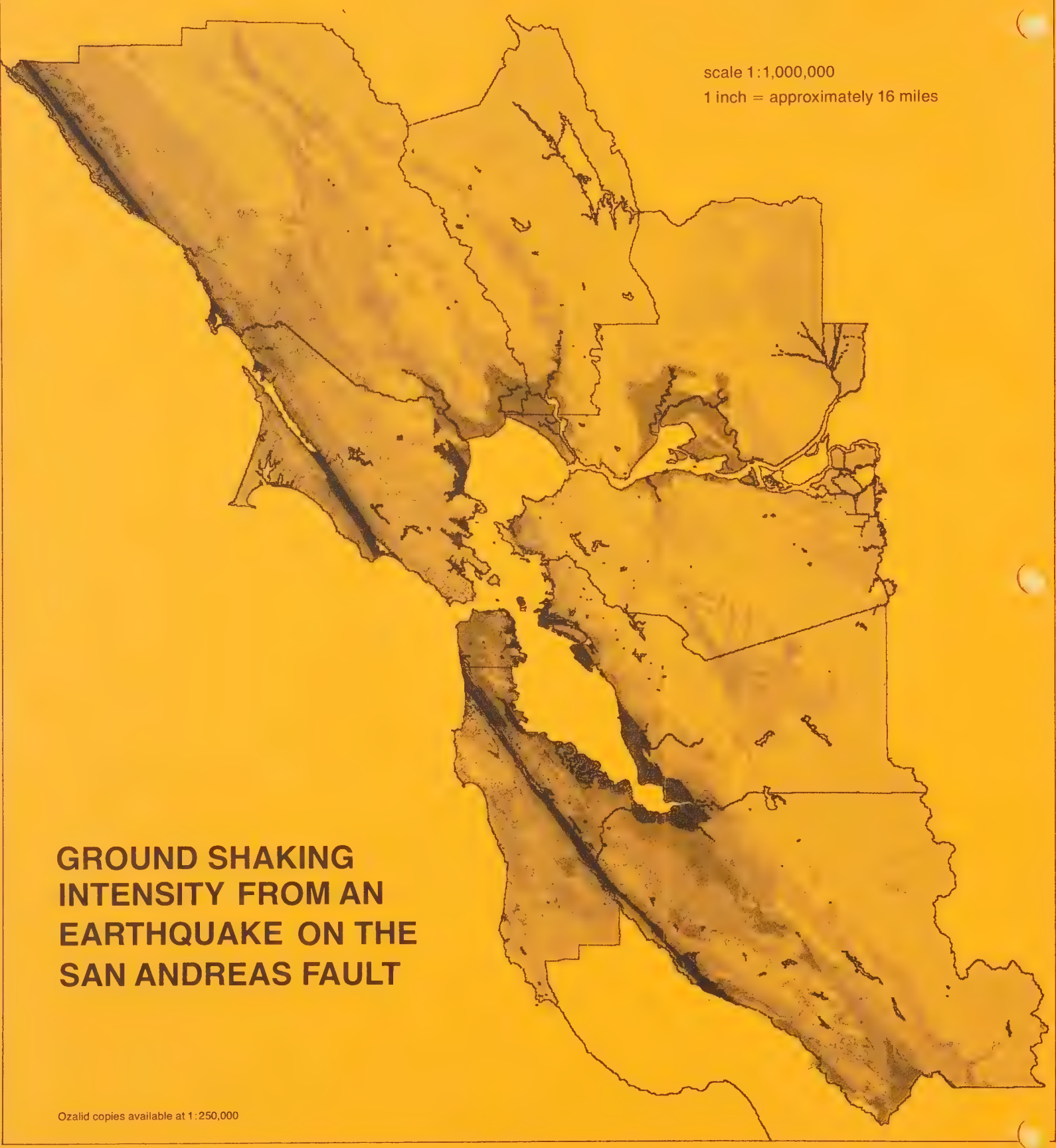
FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

- o Working Paper #17: Using Earthquake Intensity and Related Damage to Estimate Maximum Earthquake Intensity and Cumulative Damage Potential From Earthquake Ground Shaking

The general method is from USGS Professional Paper 941-A (Borcherdt and others)

LIMITATIONS AND FUTURE PLANS:

The intensity data are mapped using the San Francisco intensity scale rather than the more commonly used modified Mercali intensity scale for they are based on an empirical method developed using data from the San Francisco earthquake of 1906. Using a different attenuation relationship (such as that developed by Evernden and others at USGS) and using the modified Mercali intensity scale should change the appearance of these maps, especially near the source faults.



scale 1:1,000,000
1 inch = approximately 16 miles

GROUND SHAKING INTENSITY FROM AN EARTHQUAKE ON THE SAN ANDREAS FAULT

Ozalid copies available at 1:250,000

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MAXIMUM GROUND SHAKING INTENSITY

HAZARD MAP FILE

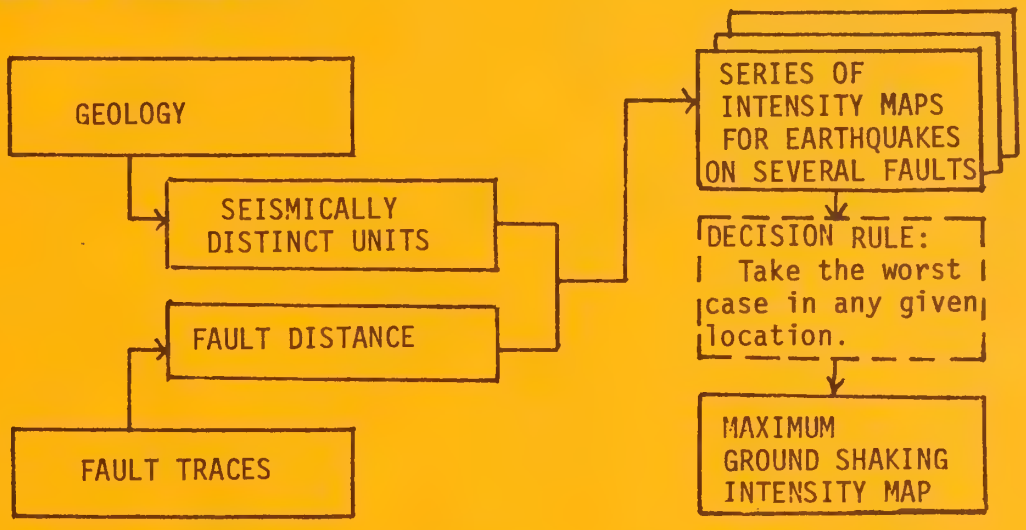
COVERAGE: All nine Bay Area counties in great detail

SOURCE: The basic data map files on faults and geology are combined to produce this map using data on:

- o maximum magnitude for each fault
- o maximum intensity associated with each maximum magnitude
- o the attenuation of intensity with distance from the fault rupture
- o the effect of local geology on that intensity

December 1983
Hectare resolution

DIAGRAM OF COMPONENTS:

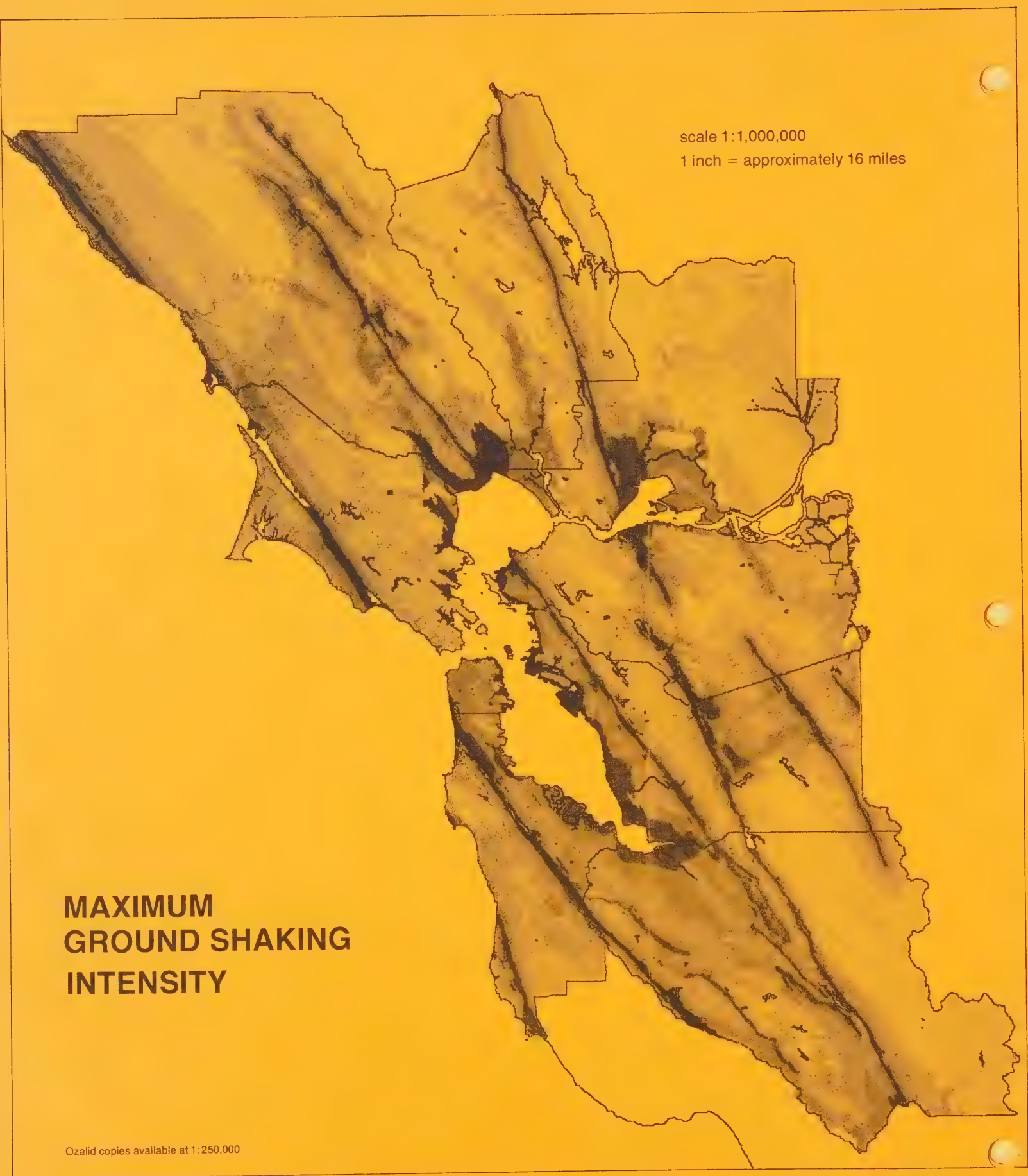

GEOLOGY
SEISMICALLY DISTINCT UNITS
FAULT DISTANCE
FAULT TRACES
SERIES OF INTENSITY MAPS FOR EARTHQUAKES ON SEVERAL FAULTS
DECISION RULE: Take the worst case in any given location.
MAXIMUM GROUND SHAKING INTENSITY MAP

FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

- o Working Paper #9: Earthquake Map Applications for Composite Earthquake Hazard Mapping
- o Working Paper #17: Using Earthquake Intensity and Related Damage to Estimate Maximum Earthquake Intensity and Cumulative Damage Potential From Earthquake Ground Shaking

LIMITATIONS AND FUTURE PLANS:

The intensity data are mapped using the San Francisco intensity scale rather than the more commonly used modified Mercali intensity scale for they are based on an empirical method developed using data from the San Francisco earthquake of 1906. Using a different attenuation relationship (such as that developed by Evernden and others at USGS) and using the modified Mercali intensity scale should change the appearance of these maps, especially near the source faults.



scale 1:1,000,000
1 inch = approximately 16 miles

MAXIMUM GROUND SHAKING INTENSITY

Ozalid copies available at 1:250,000

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CUMULATIVE DAMAGE POTENTIAL FROM EARTHQUAKE GROUND SHAKING

HAZARD MAP FILE

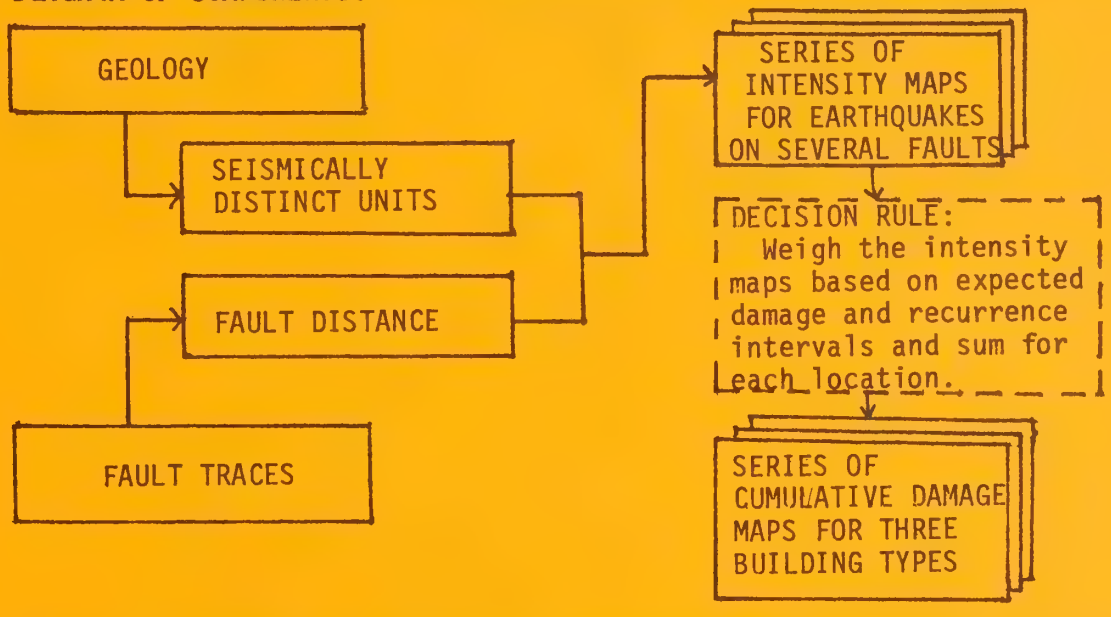
COVERAGE: All nine Bay Area counties in great detail

SOURCE: The basic data map files on faults and geology are combined to produce this map using data on:

- o frequency of different magnitudes of earthquakes on each fault
- o damage associated with each intensity
- o the source data used in the maximum ground shaking intensity file
- o the effect of local geology on that intensity

December 1983
Hectare resolution

DIAGRAM OF COMPONENTS:


GEOLOGY
SEISMICALLY DISTINCT UNITS
FAULT DISTANCE
FAULT TRACES
SERIES OF INTENSITY MAPS FOR EARTHQUAKES ON SEVERAL FAULTS
DECISION RULE: Weigh the intensity maps based on expected damage and recurrence intervals and sum for each location.
SERIES OF CUMULATIVE DAMAGE MAPS FOR THREE BUILDING TYPES

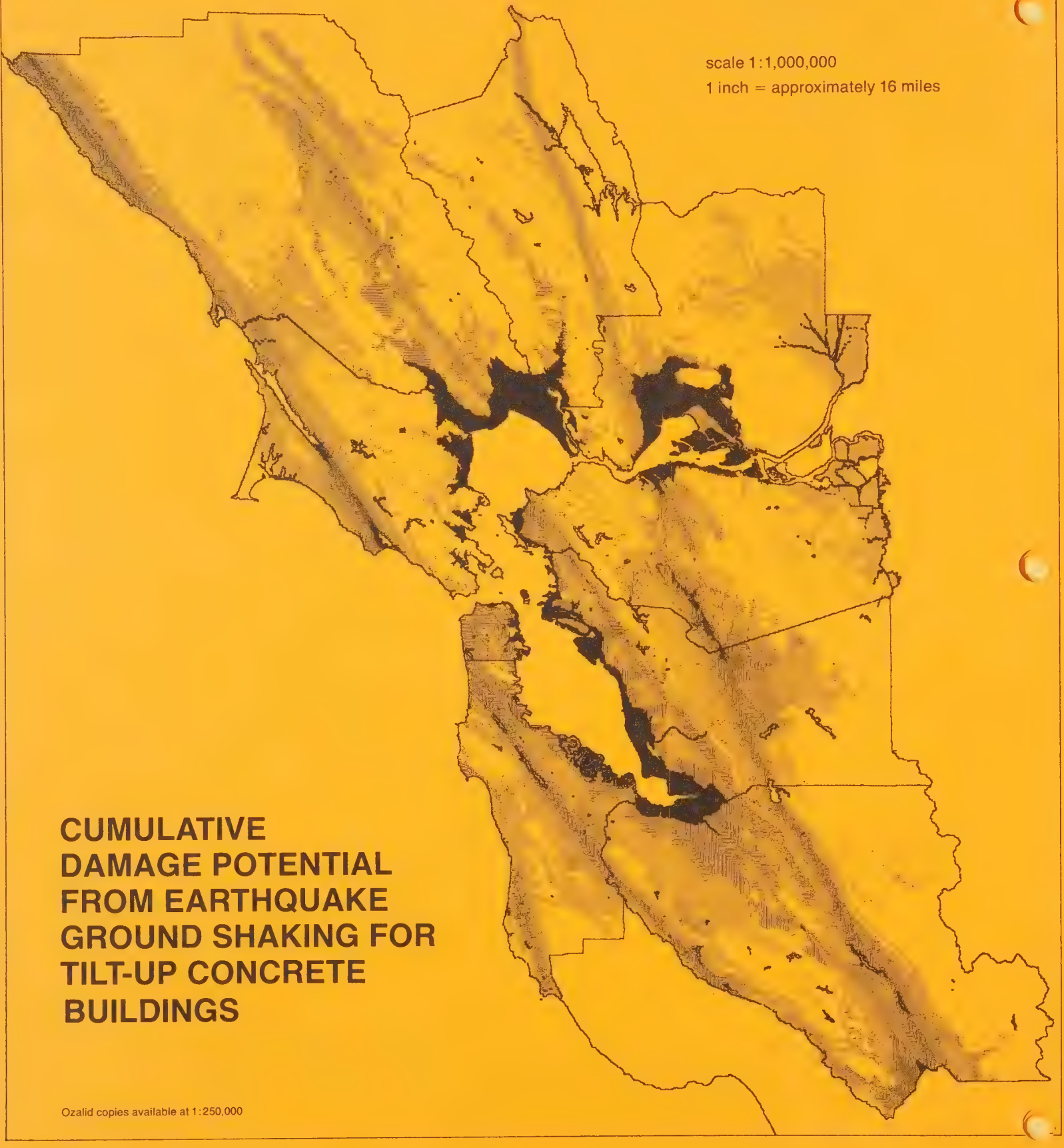
FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

- o Working Paper #17: Using Earthquake Intensity and Related Damage to Estimate Maximum Earthquake Intensity and Cumulative Damage Potential From Earthquake Ground Shaking

The general method is a refinement of a technique described in an earlier ABAG publication, Earthquake Intensity and Expected Cost (1978).

LIMITATIONS AND FUTURE PLANS:

Better data on recurrence intervals of various magnitudes of earthquakes and on the long term slip rate of faults would improve the reliability of the file. The damage data and resulting risk data are statistical and can be applied to buildings for comparison only.



scale 1:1,000,000
1 inch = approximately 16 miles

CUMULATIVE DAMAGE POTENTIAL FROM EARTHQUAKE GROUND SHAKING FOR TILT-UP CONCRETE BUILDINGS

Ozalid copies available at 1:250,000

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FAULT STUDIES ZONES

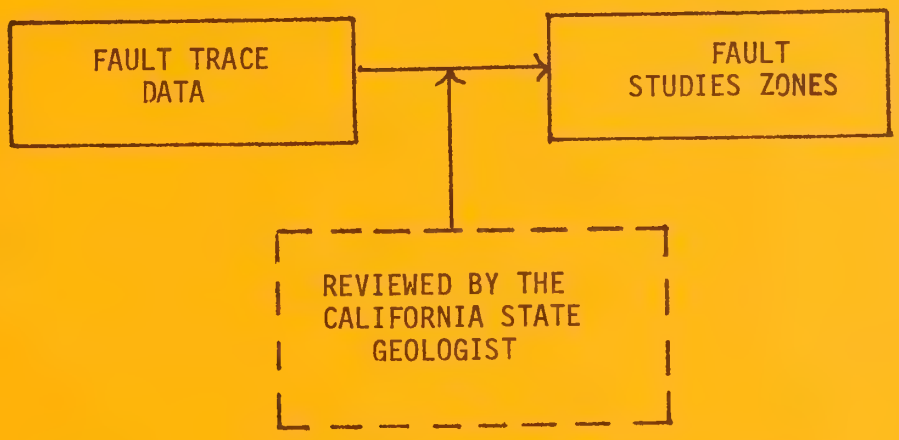
HAZARD MAP FILE

COVERAGE: All nine Bay Area counties

SOURCE: The data on fault traces were used by the California State Geologist to designate zones approximately 1/4 mile wide where geologic investigations are required to avoid building on active faults due to the hazard of surface rupture. This process is pursuant to the Alquist-Priolo Special Studies Zones Act.

December 1983
Hectare resolution

DIAGRAM OF COMPONENTS:

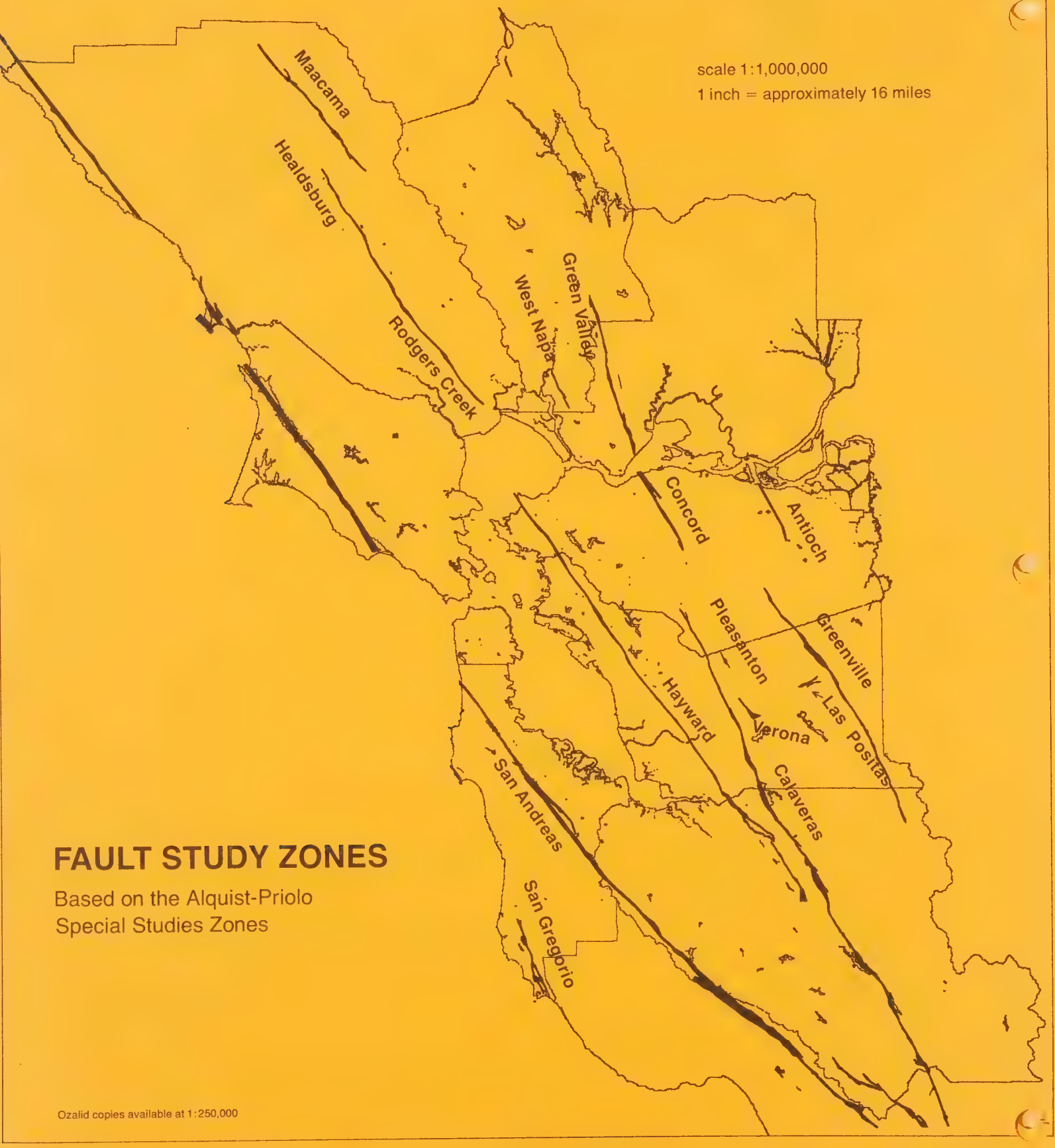


FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

- Working Paper #9: Earthquake Map Applications for Composite Earthquake Hazard Mapping
- Working Paper #17: Using Earthquake Intensity and Related Damage to Estimate Maximum Earthquake Intensity and Cumulative Damage Potential From Earthquake Ground Shaking

LIMITATIONS AND FUTURE PLANS:

As new information on fault activity becomes available, California Division of Mines and Geology staff will modify the maps used as a basis for this file. The hazard file should be modified accordingly.



FAULT STUDY ZONES

Based on the Alquist-Priolo
Special Studies Zones

Ozalid copies available at 1:250,000

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Bay Area Spatial Information System

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ASSOCIATION OF BAY AREA GOVERNMENTS

WORKING PAPERS
(as of December 1983)

The working papers referenced in this guide are not automatically included in this document. They can be ordered from ABAG's offices at a small charge. This user's guide, complete with all Working Papers, has automatically been forwarded to the planning director in each city and county in the Bay Area.

The available working papers include:

#1 - Faults and Ground Shaking Intensity -- replaced by Working Paper #17

#2 - Attenuation, Geologic Materials and Ground Shaking -- replaced by Working Paper #17

#3 - Damage and Ground Shaking Intensity -- replaced by Working Paper #17

#4 - Liquefaction Potential Mapping -- a description of the likelihood of finding cohesionless sediments within a geologic map unit, the likelihood that those sediments (when saturated) would be susceptible to liquefaction, the likelihood of finding those sediments saturated, and liquefaction opportunity (based on recurrence intervals of earthquakes and the distance from various faults at which liquefaction can occur)

#5 - Slope Stability Mapping -- a description of how slope, geology and existing landslides can be used to estimate landslide susceptibility in an earthquake and under more normal circumstances in San Mateo County

#6 - Tsunami Inundation Areas -- a description of the data used to develop a tsunami hazard map and of the relative risk associated with tsunamis

#7 - Dam Inundation Areas -- a description of dam inundation mapping and of the relative risk associated with dam failure

#8 - Earthquake Map Applications for Automated Environmental Impact Assessment -- a description of how hazard map files can be used to produce a background document for development proposals that can be incorporated into an Environmental Impact Report

#9 - Earthquake Map Applications for Composite Earthquake Hazard Mapping -- a description of how the various hazard maps can be combined to yield two types of hazard maps of total earthquake associated damage

#10 - Earthquake Map Applications for Automated Assessment of Property and Population at Risk -- a description of how tables of area in cities, counties, census tracts and land use types can be created for each hazard map category, as well as some sample tables with a discussion of the conclusions that can be formed. In addition, the feasibility of disaggregating census tract data on population using land use to create data on population at risk in various hazard categories is discussed.

#11 - The Method Developed to Extend Detailed Map Information Beyond San Mateo County to Selected Areas of Significant Development Pressure -- a description of the process used to select the areas of development pressure, the refinements and extensions of the geology, landslide, and topography files, and the extensions of the intensity maps, landslides susceptibility maps, and composite maps to the Petaluma and ridgelands areas. (The intensity map discussion is superceded by Working Paper #17.)

#12 - Ordering and Using Earthquake Hazard Maps in Local General Plans -- a description of the types of maps available, their relationship to maps recommended for inclusion in local plans by the State Office of Planning and Research General Plan Guidelines, and the scale and form in which those maps are available

#13 - Automated Environmental Impact Assessment - An Update -- a description of the revised setting and impacts section and an extensive description of possible mitigation measures

#14 - Using Earthquake Hazard Maps for Site Screening and Anticipating Mitigation Benefits and Costs -- a description of the use of these maps for pointing to areas that should be easier to develop in a safe manner, as well as for warning of the costs associated both with potential damage and with necessary hazard mitigation

#15 - Assessment of Current and Projected Property and Population at Risk - An Update -- a description of tabulations of population at risk, rather than land area, the issues surrounding the development of a risk map based on existing building types, comparisons of various methods of estimating earthquake losses, and comparisons of existing and projected risk. San Mateo County is used as a study area.

#16 - Detailed Map Information for Selected Existing Urbanized Areas and Landslide Susceptibility Hazard Map Refinement -- a description of the methods for choosing those areas for additional detailed hazard mapping, extending the bedrock geology, landslide and topography files to them, and producing the landslide susceptibility maps for the central Bay Area

#17 - Using Earthquake Intensity and Related Damage to Estimate Maximum Earthquake Intensity and Cumulative Damage Potential from Earthquake Ground Shaking -- a description of the general data needed to produce the series of individual intensity maps and the additional data needed to combine these maps to produce either a maximum intensity map or maps showing risk of damage (revised in December 1983)

#18 - Using Earthquake Hazard Maps to Analyze the Vulnerability of Lifeline System Locations -- a description of ABAG's use of its mapping capabilities to gather information on the location of hazardous areas relative to key lifeline system components

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